

JUNE TO AUGUST 1983

PRICE 70p

Electronics

THE MAPLIN MAGAZINE

6 13 BOOK ON 6502 RHC COLUMN 8 42 48 59 60 DRIC BOOK

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Shopping by TELEphone
service is launched

JUNE 83 TO
AUGUST 83
VOL 2 NO.7

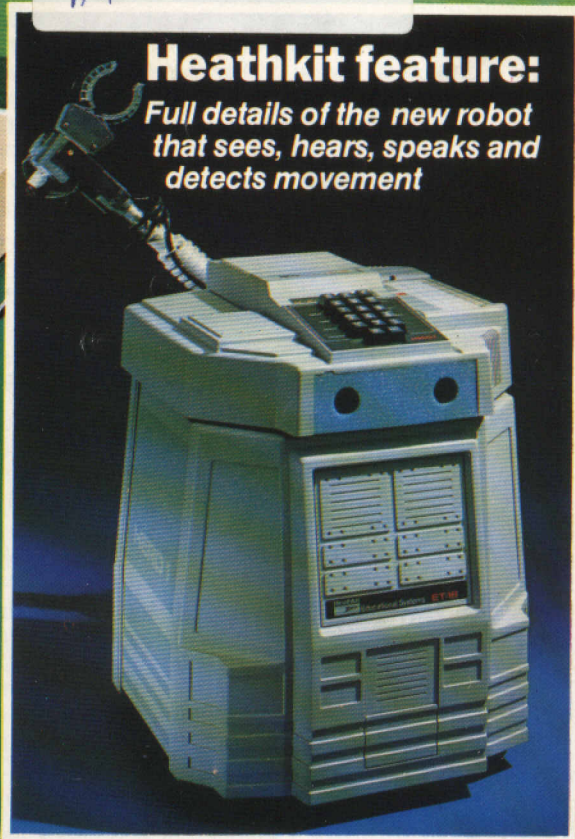
P40 DATA ON
SWITCHING 45 12
DATA SELECTOR

P26 ERROR
C8 now 68 NF
ALARM CIRCUIT



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You will, of course, need a modem like the one we published in issue 5 and if your micro doesn't have an RS232 interface then you'll need an interface as well. In this issue we've got interfaces and communications programs for the ZX81 and VIC20 and we'll have details of interfaces for most of the popular home micros in later issues.

In this issue we are pleased to launch our new range of Heathkit products. These superbly documented kits and educational courses are now available exclusively through Maplin in the UK. Over the next six months we shall be taking on most of the Heathkit range and in future issues of this magazine, we shall be looking at some of the more unique kits in greater depth.

Certainly the most fascinating new kit is the robot Hero 1. This incredible little fellow will, we hope, be with us at forthcoming exhibitions from about July onwards. In between times he'll be in our shops in rotation, but probably not until August. Your local store will know when Hero will be visiting them after August.

Finally, we're pleased to tell you that all the back issues of this magazine from our first year are now available again, reprinted as Projects Books. These are proving incredibly popular and we're actually on our third reprint of issue 2! We're also very pleased that the circulation of this magazine continues to increase by leaps and bounds, but more about that in our smashing next issue!

Cover illustration by Tony Worsfold

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Electronics

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Published by

Printed by
Typeset by
Distributed by

Maplin Electronic Supplies Ltd,
 P.O. Box 3, Rayleigh, Essex
 Eden Fisher (Southend) Ltd
 Quillset Typesetting
 Spotlight Magazine Distribution Ltd,
 1-11 Benwell Road, London N7

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Vic20~ RS232 Interface

- ★ Allows the VIC to connect to Modems, Printers, VDUs, or any other RS232 compatible device
- ★ Converts TTL levels to true RS232
- ★ Provides full buffering for protection of computer
- ★ Full 'X line' interface possible as well as simple '3 line' interface

by Mark Brighton

RS232 is the name given to an industry standard form of serial data communication which is used on many peripheral devices to interface them with a computer.

A byte of serial data is represented by a series of transitions between +12V and -12V on a serial data line. The marks and spaces created by these transitions contain the information for the byte of data as well as some other signals, the purpose of which is to synchronise the receiving device to the serial data stream.

The format of a 'word' of data, including these synchronising signals, is as follows:

1. The start bit. This signal alerts the receiving device that a byte of data follows, and synchronises the receiver circuitry to the incoming data.
2. Data bits. This is the ASCII encoded data, and may consist of seven or eight bits as selected by the user. It is sent least significant bit first.
3. The parity bit. This is an optional error checking bit selected by the user to conform with the requirements of the receiving set. It may be set for odd or even parity, or disabled.
4. Stop bit(s). These are one or two bits of data which are transmitted at the end of a word to separate it from the next word.

The polarity of these signals may be selected by sending normal or inverted data, either of which may be required by different devices. Apart from the serial data lines (SIN and SOUT), several other status and handshake signals are provided.

Those available on the VIC 20 are:

1. Data terminal ready (DTR). This signal is sent to indicate that the data

terminal is ready to send or receive data.

2. Data set ready (DSR). This indicates that the data set is ready to send or receive data.

3. Request to send (RTS). This signal tells the receiving device (usually called the 'data set') that the VIC (data terminal) wishes to send data.

4. Clear to send (CTS). This allows the data set to signal that it is ready to pass data from the data terminal.

5. Carrier detect (DCD). This lets the data set tell the data terminal that the communication link is established.

In addition to those lines already mentioned, there are two ground lines, protective ground and signal ground. Signal ground must always be connected, since RS232 requires that both devices have equal ground potential.

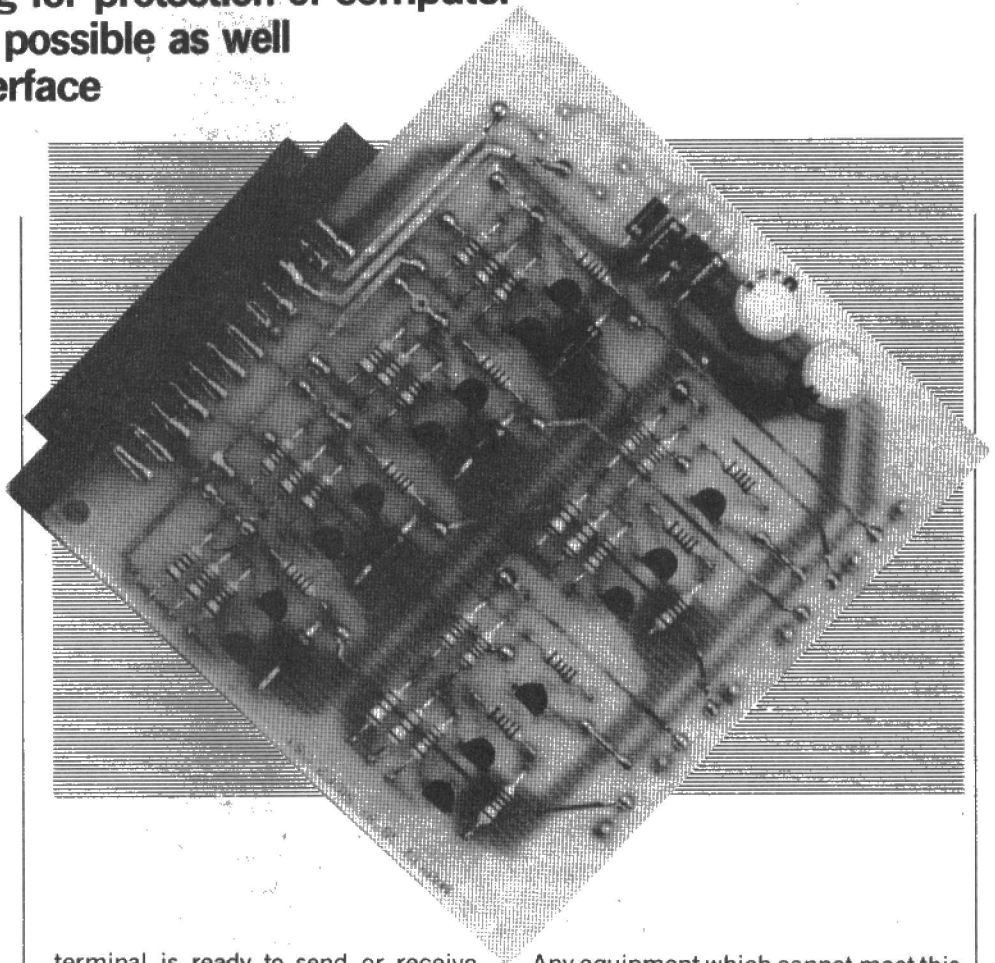
Any equipment which cannot meet this requirement is not RS232 compatible.

Circuit Description

The circuit consists of two transmit channels and four receive channels, with a power supply which provides approximately +12 and -12V from the 9V AC output on pins 10 and 11 on the user port.

Transmit Mode

SOUT from the VIC (pin M, user port) is connected to the base of TR9 via a 10k Ω resistor, R17. As TR9 turns on, bringing its collector down to 0V, TR10 turns on, raising its collector voltage to +12V. The normal, or non-inverting, output is taken via R23, a 330 Ω resistor which limits the current that may be drawn from this output to about 30mA.



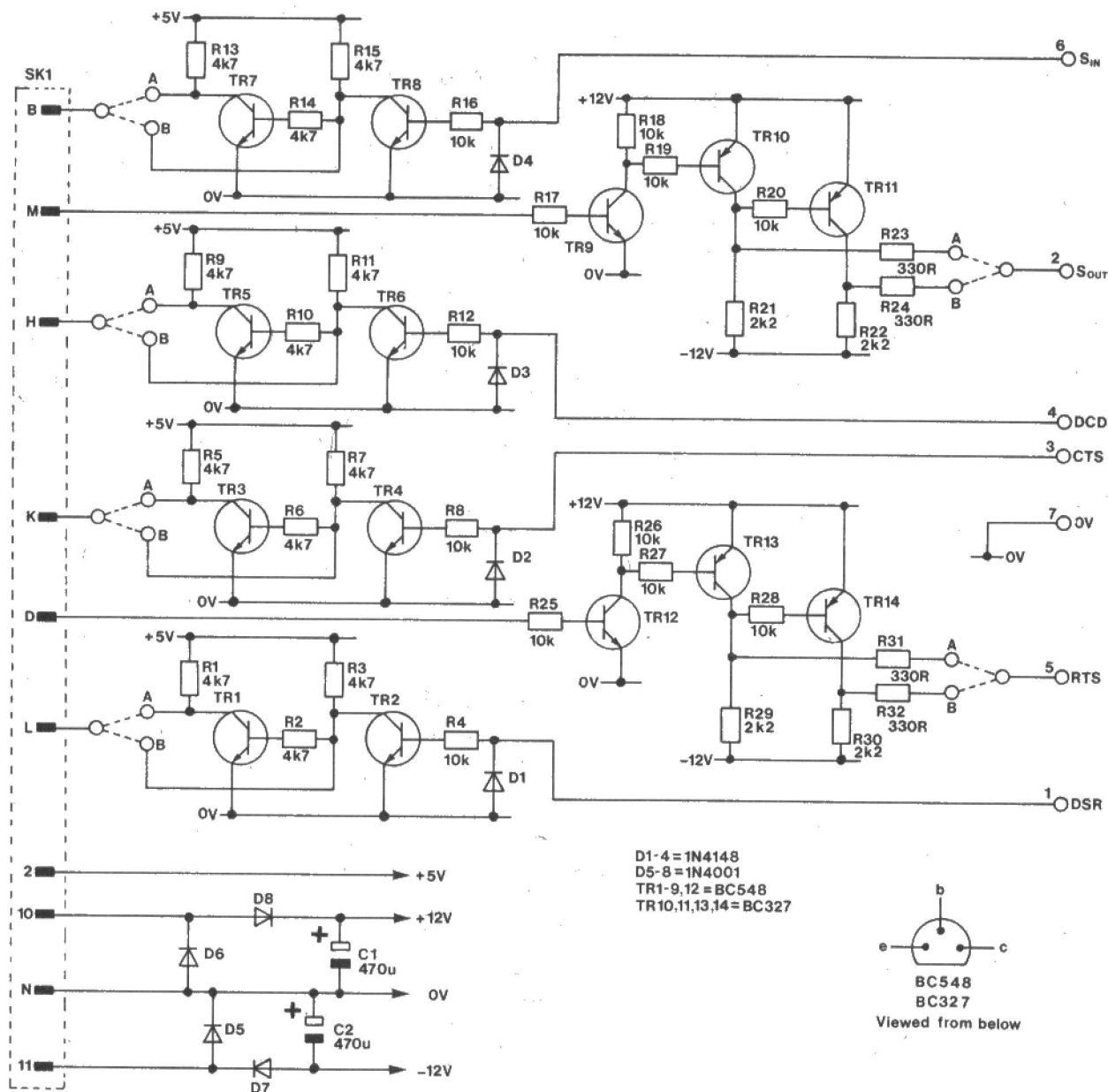


Figure 1. Circuit diagram

A second output stage is also driven from the collector of TR10, and this is identical in operation except that the output is inverted with respect to the input. The output that is used depends on the requirements of the data set.

Receive Mode

The incoming signal first has any negative content removed by D1. It then turns TR2 on and off via R4. The inverting output of the receive circuit is taken from the collector of TR2 which also drives TR1 via R2 to obtain a non-inverting output at the collector of TR1. The choice of which output to wire to the VIC is determined by the polarity of the incoming data. The VIC requires a signal which sits high between 'words' and drops low for data. S_{IN} is on pins B and C on the port, and these are connected together.

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Construction

Referring to the circuit diagram and parts list, first insert all through pins (see figure 1 for signal polarity pins) and Veropins. Solder them in, not forgetting to solder both sides of the through pins. Insert all other components and solder them in. Attach the edge connector to the board, bending its pins flush with the pads on the board, and solder. Clean the board thoroughly and inspect for dry joints, shorts etc.

Testing

Plug the board into the user port, component side upwards, and switch the computer on. If the computer fails to initialise, switch off and re-check carefully for incorrectly placed components, etc. After the computer initialises,

measure test points 1 to 4 with a multimeter. These readings should be approximately as follows:

- TP1 — 0V
- TP2 — +5V
- TP3 — +12V
- TP4 — -12V

If all is well, switch off the VIC and remove the interface card. Wire the board to the data set. Reconnect to the VIC, switch both the VIC and data set on, and type in program A. Run the program, and the receiving party should receive the message 'the quick brown fox jumps over the lazy dog' continuously. Also included is a program to make the VIC act like a 'dumb terminal', for use with a modem, to call information and ordering services such as the Maplin on-line computer, South-end (0702) 552941.

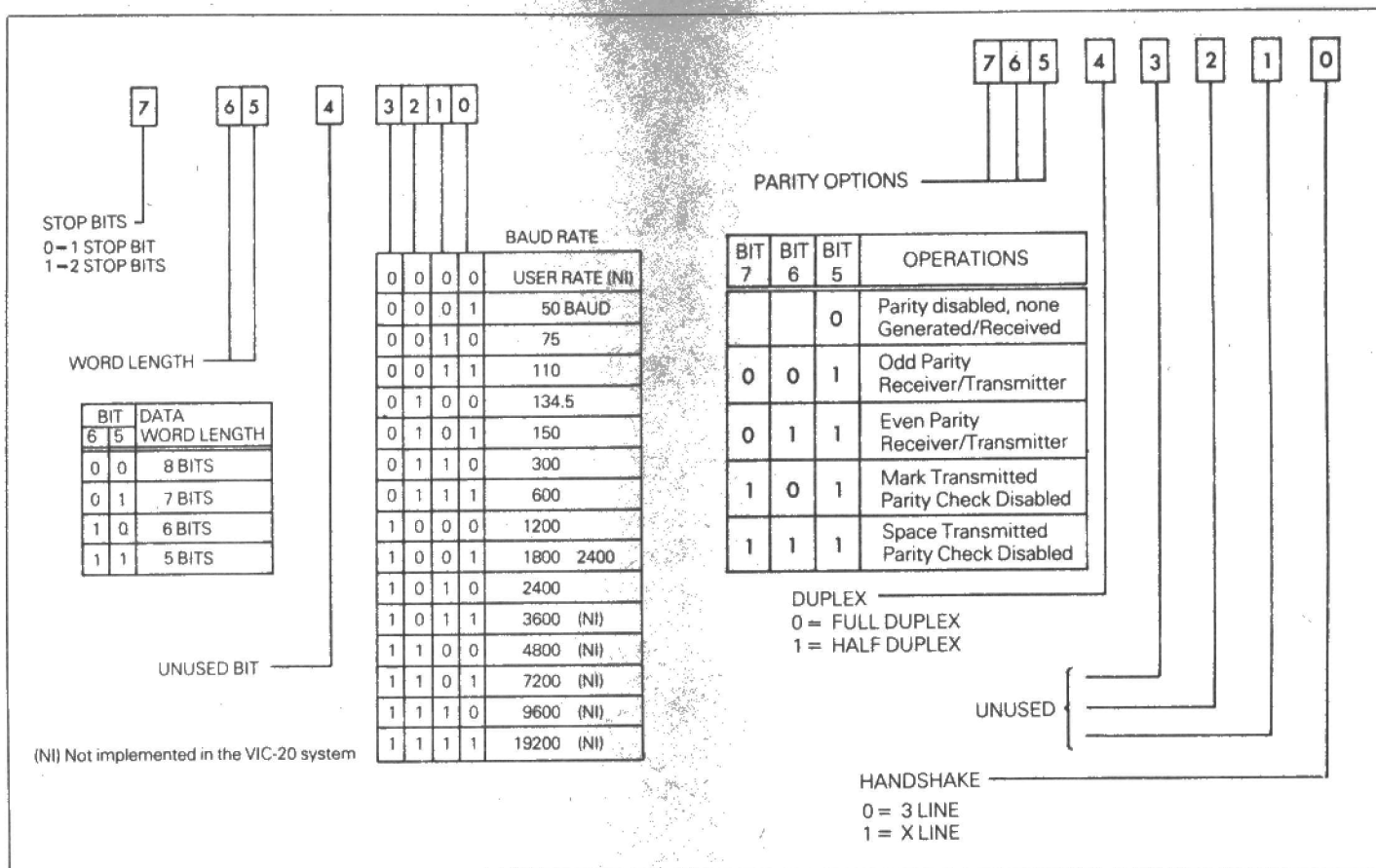


Table 1. Function of bits in the VIC RS-232 Control Register

Table 2. Function of bits in the VIC RS-232 Command Register

```

10 REM***PROGRAM A ***
20 OPEN200,2,0,CHR$(166)+CHR$(0)
30 PRINT#200,"THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG."
40 GOTO30

```

```

0 REM***** * V.D.U. PROGRAM * *****
1 POKE36879,8:PRINTCHR$(5):WAIT 203,64
5 POKE36876,200:PRINTCHR$(147);" VIC 20 V.D.U. PROGRAM"
10 R$=CHR$(166)+CHR$(0)
20 OPEN200,2,0,R$
25 IFPEEK(203)<>64THEN500
30 GET#200,A$
35 IFA$=""THENGOTO25
40 IF ASC(A$)>95THENGOTO25
50 IF A$=CHR$(13)THENPRINTA$;:GOTO25
60 IF ASC(A$)<32THENGOTO25
70 PRINTA$;:GOTO25
500 POKE203,64:GETS$
510 IFS$=CHR$(17)THENS$=CHR$(10)
520 IFS$=CHR$(19)THENS$=CHR$(140)
530 PRINT#200,S$;:POKE203,64:S$="":GOTO30

```

PARTS LIST FOR VIC 20 RS232 INTERFACE

Resistors — All 0.4W 1% Metal Film

R1,2,3,4,5,6,7,9, 10,11,13,14,15	4K7	12 off	(M47K)
R4,8,12,16,17,18, 19,20,25,26,27, 28	10K	12 off	(M10K)
R21,22,29,30	2k2	4 off	(M2K2)
R23,24,31,32	330R	4 off	(M330R)

Capacitors

C1,2	470uF 16V P.C. Electrolytic	2 off	(FF15R)
------	-----------------------------	-------	---------

Semiconductors

D1-4 inc.	1N4148	4 off	(QL80B)
D5-8 inc.	1N40001	4 off	(QL73Q)
TR1-9 inc., 12	BC548	10 off	(QB73Q)
TR10,11,13,14	BC327	4 off	(QB66W)

Miscellaneous

SK1	P.C. Edgecon 2 x 12 way		(BK74R)
	Veropin 2141	1 Pkt	(FL21X)
	Track Pin	1 Pkt	(FL82D)
	P.C.B.		(GB28F)

A complete kit of all parts is available.
Order As LK11M (VIC 20/RS232 Interface kit). Price £9.45.

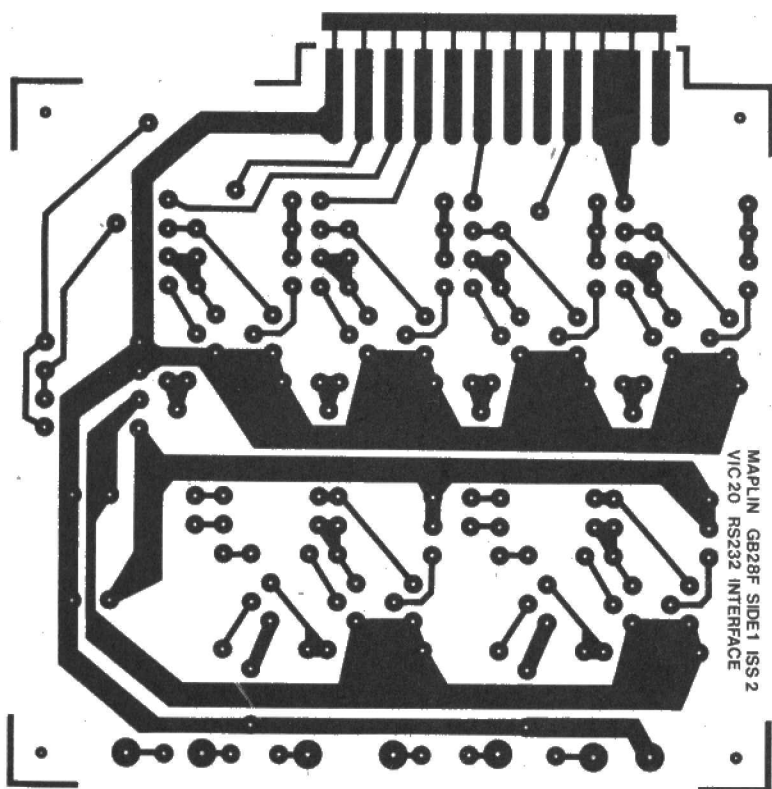
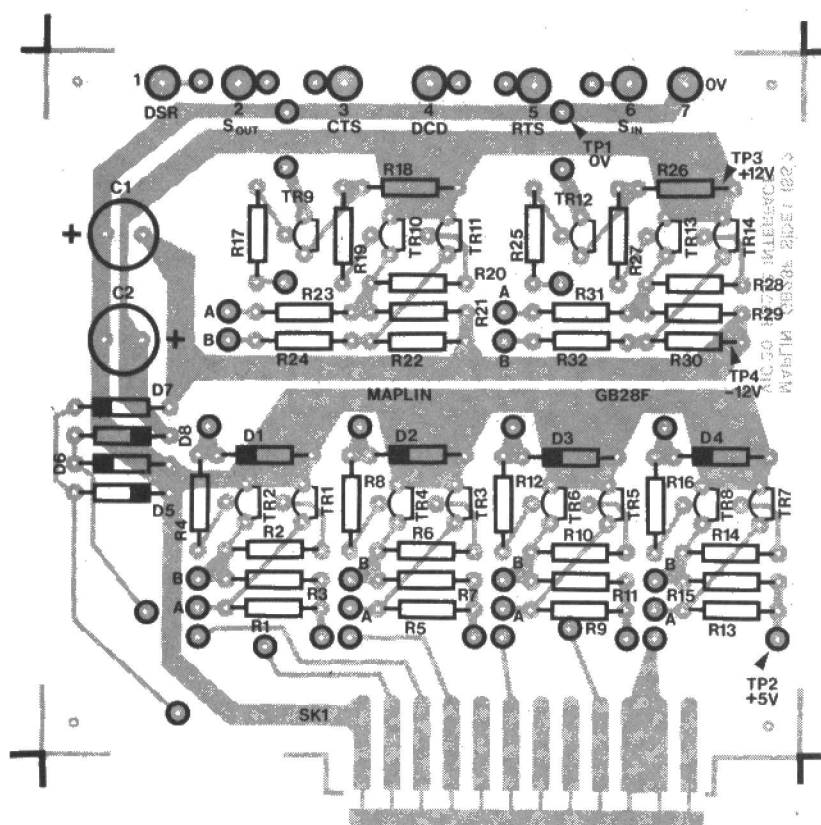


Figure 2. PCB layout

Usage

To use the RS232 serial data port on the VIC the channel must first be opened as a file, specifying Baud rate (speed), number of bits per character, number of stop bits, and odd/even or disabled parity bit. This information is given by two characters after the 'OPEN' command in the form:

OPEN LF,2,0,A\$. Where LF is the logical file number, i.e., any number between 1 and 255 (if LF is greater than 127, then linefeed follows carriage return), and A\$ is two characters sent to control register and command register, the functions of which are explained in tables 1 and 2. So, for example, we can see that to set Baud rate to 300, 7 bits per character, 2 stop bits, and no parity, the OPEN command would be:

OPEN 200,2,0,CHR\$(166)+CHR\$(0).
Having opened the RS232 channel, data is sent and received using 'PRINT LF,DATA \$' and 'GET LF,DATA \$'.

Note: To type 'PRINT' do not use the abbreviation 'P'. Instead, use 'P shift R' followed by logical file number etc. It is possible to list through the RS232 port, to send a program to a friend for instance, by typing 'CMD LF : LIST', where LF=logical file number.

Remember when programming that the VIC allocates two 256 byte buffers (for transmit and receive) in the 506 bytes below RAMTOP, so there is less memory available to BASIC. Also 'DIM' statements or variables should be left until after the 'OPEN' command, as the computer performs an automatic 'CLR' before allocating the buffers.

Bibliography:

VIC Revealed by Nick Hampshire
VIC Programmers Reference Guide,
Commodore

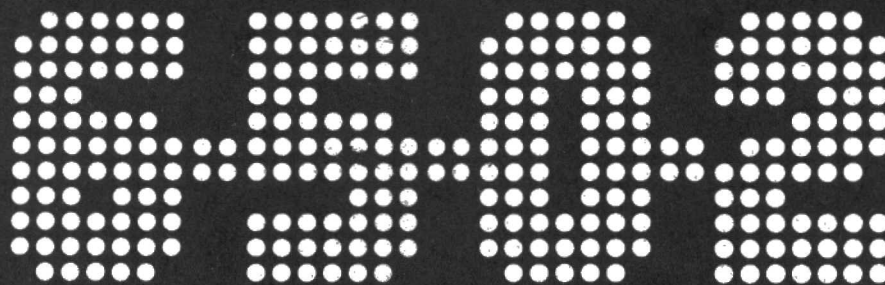
Connecting to the Maplin Modem

With reference to figure 5, page 5, issue 5 of Electronics, the following connections should be made:

VIC 20 Interface	Maplin Modem
pin 2 (SOUT)	to pin 17 (RS232 IN)
pin 6 (SIN)	to pin 10 (RS232 OUT)
pin 7 (SGROUND)	to pin 21 or 22 (SGROUND)

Ensure that the link on the Modem is in the RS232 position.

MACHINE CODE PROGRAMMING WITH THE



Part One

Graham Dixey C.Eng., M.I.E.R.E.

Introduction

The 6502 MPU from MOS Tech is one of the most popular microprocessor chips and is used in a number of well known microcomputers including PET and Apple. However, in machines of this type the MPU is usually wedded to BASIC software and interfaced to an ASCII keyboard and VDU. Apart from the addition of a cassette deck and a printer and, for the more affluent, a 'floppy disc' system most people regard this as the limit of their peripherals. In such 'high level language' operation, memory capacities from 4K to 64K are the rule; in fact more exotic games, for example, demand large amounts of memory. Therefore, some may be surprised to learn that MPUs can perform a whole variety of interesting and useful functions with only 1K to 2K of RAM. A VDU is quite unnecessary and the man/machine interface consists solely of a HEX keypad and a seven-segment display. This was the concept of such microcomputers as Science of Cambridge's Mk14, AIM 65 Acorn's System One, KIM, etc, the last three all using the 6502. But the more sophisticated computers such as PET and Apple can also usually be programmed in machine code. One result of this is that, since they also contain an input/output chip, they can be used for control functions as well as the more usual keyboard/VDU usage.

There have been many series and there are many books that teach BASIC programming, since this is a very popular high-level language. What this series aims to show is that machine-code programming is an entirely logical process which is not too difficult to learn and which can also be great fun and a source of satisfaction. Therefore, if you feel like a change from 'Pacman' or nested FOR/NEXT loops, this series will offer you the chance to write effective programs in 6502 machine code. Using the computer in this way will teach you a lot more about it at 'grass roots' level than you will ever learn in programming in BASIC and will greatly increase your ability to realise your computer's potential more fully.

The Choice of Chip

The 6502 has been chosen for this series for several reasons:

(i) there are many microcomputers using this chip

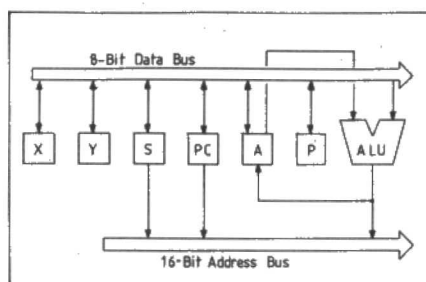


Figure 1. Simplified Architecture of the 6502.

(ii) the architecture and instruction set are both quite straightforward and easily learnt
(iii) the author has, for the past couple of years, been teaching machine-code programming on a 6502-based machine and has demonstrated its capabilities in a practical environment.

Why Machine-Code Programming?

There is no doubt that a program written in machine-code to perform even a fairly simple function takes very much longer to write and encode than its equivalent in BASIC. This is not because there is some magic about BASIC that permits this; it is not super-efficient, far from it in fact. There is one fundamental fact that is so obvious that it is likely to be overlooked — every MPU, no matter what function it is performing, is working in binary and using machine-code. It is the presence of software, in the form of a BASIC interpreter, that allows the user to bypass the low-level operation and enter the commands, etc in English. This need to interpret the high-level input actually slows down the computer when the program is run.

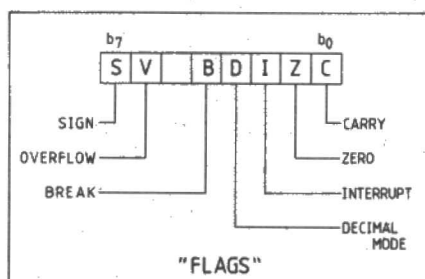


Figure 2. The 6502 Processor Status Register.

When the BASIC interpreter is not used, all commands are entered in machine-code and the programmer has the utmost flexibility in the use of the machine, limited almost entirely by his own imagination and wits. Programs, although taking longer to write, will run very much faster than high-level programs. The low-level language is directly concerned with data transfers between MPU registers, memory locations and input/output ports. As a result, inputs from various types of transducer, switches, etc are processed and decisions made from the input data that will produce signals on output lines to energise relays, motors, solenoids, lamps, etc or even generate a variety of output waveforms. Because of the sequential nature of the program, control sequences are possible giving rise to completely automatic decision-making systems, hence MPU-controlled washing machines, robotics, process-control systems, safety systems, etc. Machine-code programming, in short, opens up a whole new world of possibilities.

Enter the 6502

A good starting point for learning about the 6502 is its 'architecture'. This is shown, in simplified form, in Figure 1. For programming purposes the essential details are the various registers and the arithmetic/logic unit (ALU), the full functions of which will be made clear as the ideas of programming develop. For the moment, a simple statement about each will suffice as an introduction. There is also the system 'clock', which is usually crystal-controlled and can be thought of as the co-ordinator of events in the computer.

The 6502 has only six registers, as follows:—

The Accumulator (A): This, the first in importance, is an 8-bit register which is used in most computer operations. Like any other register or memory location, it is nothing more than a 'string' of flip-flops arranged to store a byte of binary information.

The Index Registers (X & Y): These two registers, which are more or less identical, are also eight bits wide and are extremely useful in a variety of ways, which will be introduced fully as the series develops.

The Program Counter (PC): This is a 16-

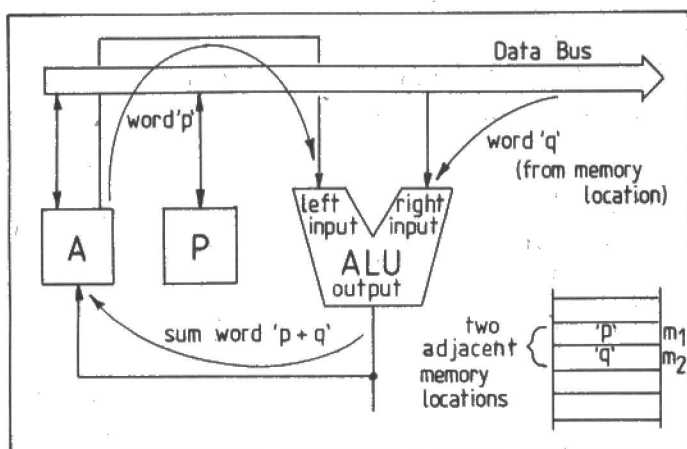


Figure 3. The Arithmetic-Logic Unit: flow of data during an addition.

bit register, which holds, sequentially, the addresses at which the program is stored during the normal course of running a program. Otherwise it may be thought of as holding the address of the next instruction to be accessed. As it is 'incremented' the computer steps through the program.

The Processor Status Register (P): Another 8-bit register, each bit of which is an independent 'flag'. Because of its particular importance and usage, this register is shown in more detail in Figure 2. Each flag is nothing more than a flip-flop which is either SET (equal to 1) or CLEAR (equal to 0). Whether a flag is SET or CLEAR depends upon the result of some previous computer operation.

For example, if a number held in the accumulator is negative, the negative flag (N) will be set; otherwise it is clear.

If, however, the number held is zero, then the zero flag (Z) is set.

If, during an addition, a 'carry' is produced, the carry flag (C) will be set.

From these few examples it is possible to see that decisions can be made during the course of a program by testing various flags to see if a particular result has occurred.

The Stack Pointer Register (S): In the 6502 this is a 9-bit register with its most significant bit set permanently at '1'. Its purpose is to 'point' to an address in an area of the RAM known as the 'stack'. The purpose of the stack will be made clear in due course but, for now, it will be stated that it is a reserved area of RAM used to 'stack' data during certain aspects of computer operation. Because the 9th bit is always set, the 6502 stack occupies the range of addresses from 0100 to 01FF in HEX.

The Arithmetic Logic Unit, or ALU for short, is where the computing is really carried out. It is shown in Figure 3 in association with the Data Bus, Accumulator and Status Register. The ALU has two 'input ports' and an 'output port'. The arrows show the flow of data during the addition of two bytes of data. If the bytes or 'words' to be added are known as 'p' and 'q' respectively, then 'p' may be placed or 'loaded' into the accumulator initially and 'q' arrives on the data bus from some memory location at a subsequent interval of time later. At the moment that the addition operation is actually carried out, both 'p' and 'q' enter the ALU by their respective input ports, and their sum then leaves the ALU by the output port where it is placed in the accumulator, thus replacing the original contents 'p'. If the addition operation yields a 'carry bit', which is effectively the 9th bit of the result, this will set the carry flag C in the Status Register (P). Thus, at least temporarily, the carry is stored for subsequent use. An example of this series of operations with sample binary data is illustrated in Figure 4.

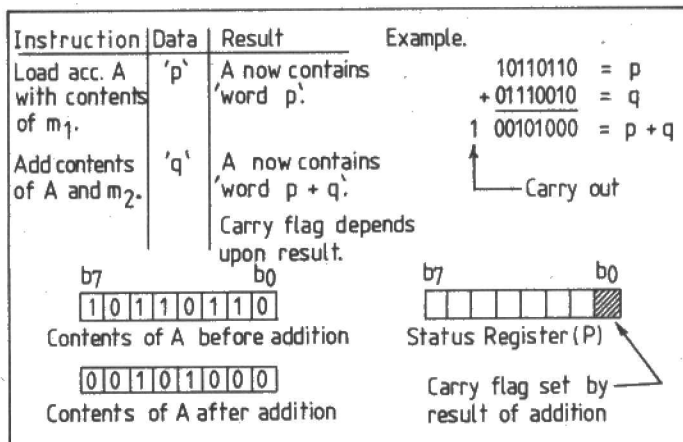


Figure 4. Example of addition and effect on the 'carry' flag.

Binary and Hexadecimal Numbers

Since computing, whatever its aim, is essentially concerned with the manipulation of numbers, the user of a computer must be fully conversant with the number systems used. As already stated, the MPU itself does all of its work in binary i.e. using '1s' and '0s' only. However, since binary numbers tend to be rather long, addresses and data are specified and entered via the keypad in hexadecimal (HEX for short), this being much more compact and less prone to error. To appreciate how binary and HEX number systems work (or indeed how any number system works) it is necessary to appreciate how a number is made up. Consider the following examples:

The denary number 255
 $= (2 \times 10^2) + (5 \times 10^1) + (5 \times 10^0)$
 $= 200 + 50 + 5$ (N.B. $10^0 = 1$),
 $= 255$

The binary number 11111111
 $= (1 \times 2^7) + (1 \times 2^6) + (1 \times 2^5)$
 $+ (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2)$
 $+ (1 \times 2^1) + (1 \times 2^0)$
 $= 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1$
 $= 255$ (denary)

Thus, denary 255 means the same thing as binary 11111111.

It should be noted that each column has a 'weighting' or power to which the base of the system is raised. In binary the base is 2 and in denary it is 10. It will be noticed in diagrams of registers that the bit position in a register is identified by its power of two. For example, in an 8-bit register the least significant bit position is called b0 (power of $2 = 0$) while the most significant bit position is called b7 (power of $2 = 7$).

How then does HEX work? The base is sixteen and since there are only ten individual digits available (0-9), it is necessary to provide six more to make up the set and this is done in practice by using the first six letters of the alphabet (A-F). Thus, these letters have to be thought of as representing numbers, such that A = 10, B = 11... F = 15. As an example, the HEX number

FF = $(F \times 16^1) + (F \times 16^0)$,
 i.e. FF = $(15 \times 16^1) + (15 \times 16^0)$,
 $= 255$ (denary).

Thus, FF is the HEX way of writing 255 (denary) or 11111111 (binary).

The problem with HEX, of course, is its unfamiliarity. It takes some practice to get to grips with it properly but, gradually, one gets the hang of it.

continued on page 13

Binary	HEX	Decimal	HEX	Decimal	HEX	Decimal	HEX	Decimal
0001	0001	1	0010	2	0100	4	1000	8
0010	0002	2	0020	32	0200	512	2000	8192
0011	0003	3	0030	48	0300	768	3000	12288
0100	0004	4	0040	64	0400	1024	4000	16384
0101	0005	5	0050	80	0500	1280	5000	20480
0110	0006	6	0060	96	0600	1536	6000	24576
0111	0007	7	0070	112	0700	1792	7000	28672
1000	0008	8	0080	128	0800	2048	8000	32768
1001	0009	9	0090	144	0900	2304	9000	36864
1010	000A	10	00A0	160	0A00	2560	A000	40960
1011	000B	11	00B0	176	0B00	2816	B000	45056
1100	000C	12	00C0	192	0C00	3072	C000	49152
1101	000D	13	00D0	208	0D00	3328	D000	53248
1110	000E	14	00E0	224	0E00	3584	E000	57344
1111	000F	15	00F0	240	0F00	3840	F000	61440

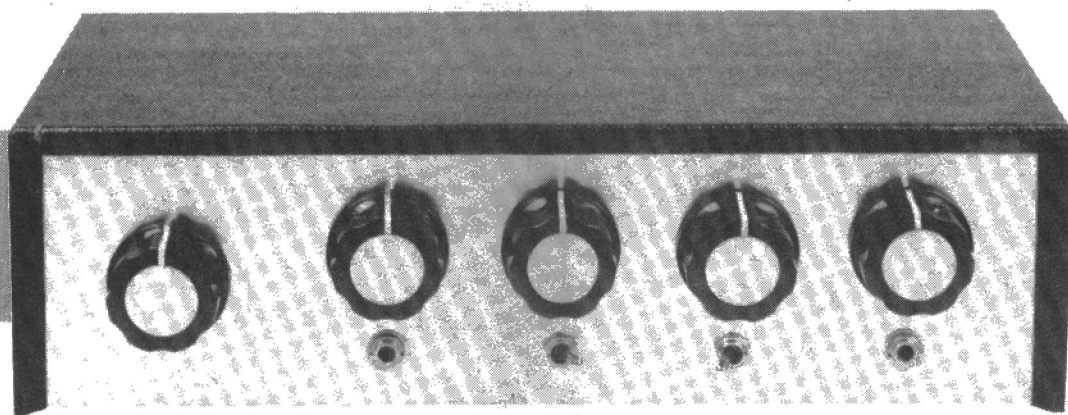
HEX to decimal: Add equivalent decimal values of each HEX digit in turn.

Decimal to HEX: Find largest HEX number less than or equal to decimal number required. Subtract decimal value of this number from decimal number required. Repeat successively for remainder until it is zero. Add HEX equivalents.

Binary to HEX and vice-versa: Replace each HEX digit with 4-bit binary group and vice-versa.

Binary to decimal and vice-versa: Convert to HEX first, as above.

Table 1. Binary — HEX — Decimal Conversion Chart.



A SIMPLE SWEEP OSCILLATOR

by Robert Penfold

For frequency response measurements most electronics enthusiasts use an audio sinewave generator plus an A.C. millivoltmeter or some other piece of equipment capable of measuring audio frequency signals. A quicker way of obtaining audio frequency response graphs is to use a sweep oscillator plus a pen recorder. Here the audio oscillator is automatically swept up through the entire audio frequency band while the pen in the recorder responds to the output signal level from the equipment under test. As the oscillator is swept upwards in frequency the paper is moved past the pen so that the required frequency response graph is drawn out, and units of this type normally have the X and Y axes accurately calibrated in terms of fre-

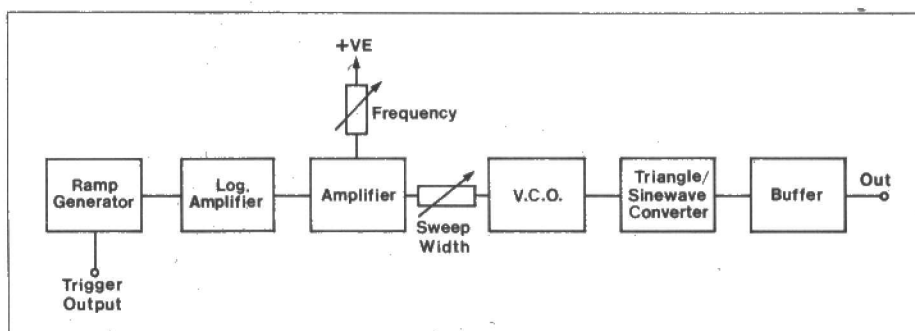


Figure 1. The simple sweep generator block diagram.

quency and relative gain in decibels so that a meaningful graph is produced.

While this method obviously saves a great deal of time by avoiding the need to write down numerous results and then (if necessary) draw a graph on the basis of these, the cost of such equipment makes it impractical for the

amateur user. However, useful results can be obtained using a simple sweep oscillator in conjunction with an oscilloscope, and a suitable sweep generator can be built at quite a modest cost. With this system the Y input of the oscilloscope is fed with the output of the equipment under test, and the spot is

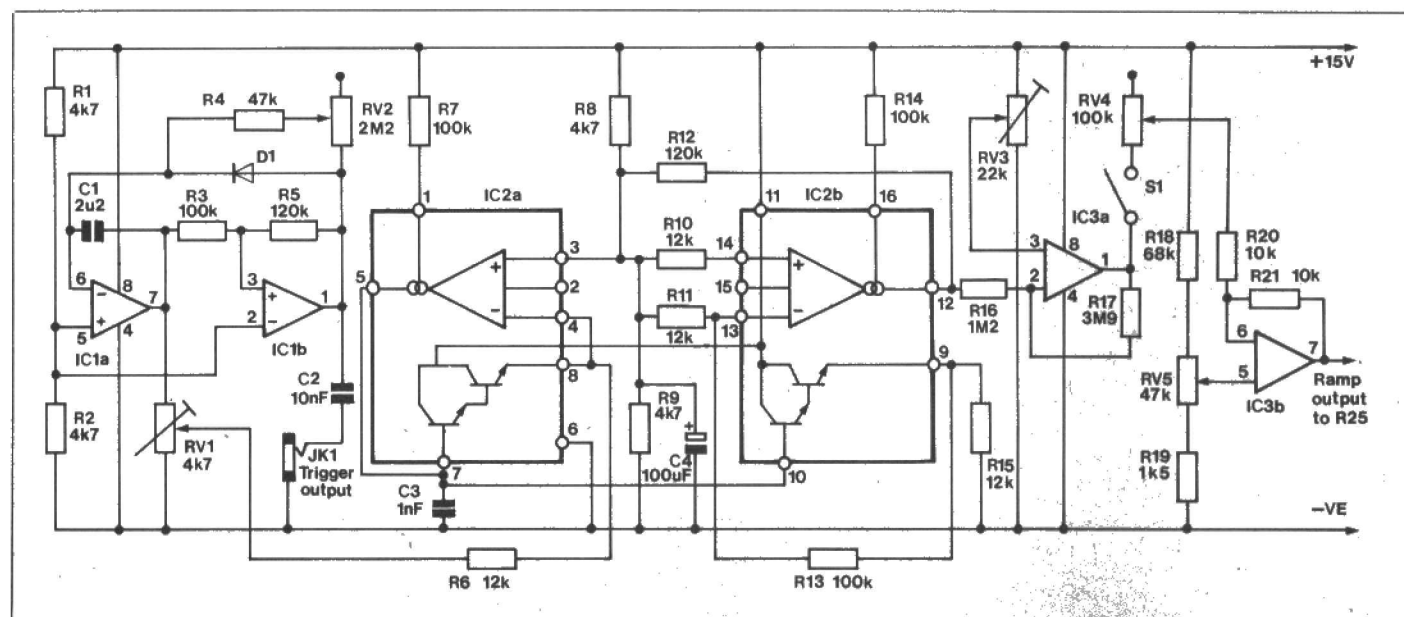


Figure 2. The ramp generator and log amplifier circuits.

swept across the screen as the oscillator is swept over the audio frequency range. The spot can either be swept across the screen using triggered sweep with the trigger signal being obtained from the sweep oscillator, or the ramp signal from the sweep oscillator can be fed to the X input of the oscilloscope.

This gives what is only a comparatively crude representation of the frequency response of the equipment under investigation, but the results obtained are perfectly adequate for making quick checks on tone controls, equalisation amplifiers, testing for irregularities in filter responses, and so on. If necessary, checks using the sweep oscillator and oscilloscope can be followed up by detailed measurements using an ordinary sinewave generator and a millivoltmeter. The accompanying oscillographs show a few examples of results obtained using the simple sweep oscillator featured in this article.

Block Diagram

A voltage controlled oscillator (V.C.O.) is at the heart of the unit, as can be seen from the block diagram of Figure 1. In this application it is not necessary for the oscillator to have a very pure output, and a distortion level of around 2% is perfectly adequate. The V.C.O. used in this design has a triangular output waveform and not the required sinewave output, and the distortion on a triangular waveform is too high to give really good results. A triangular waveform can be converted to a reasonable sinewave signal by either using a filter to attenuate the unwanted harmonics, or by using a soft

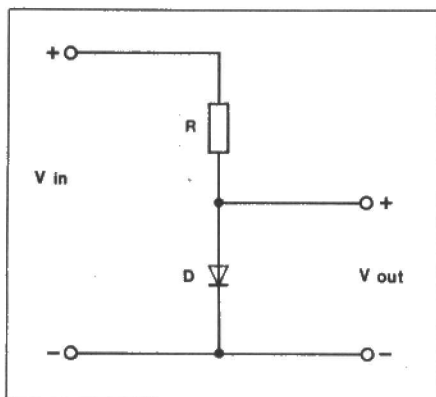
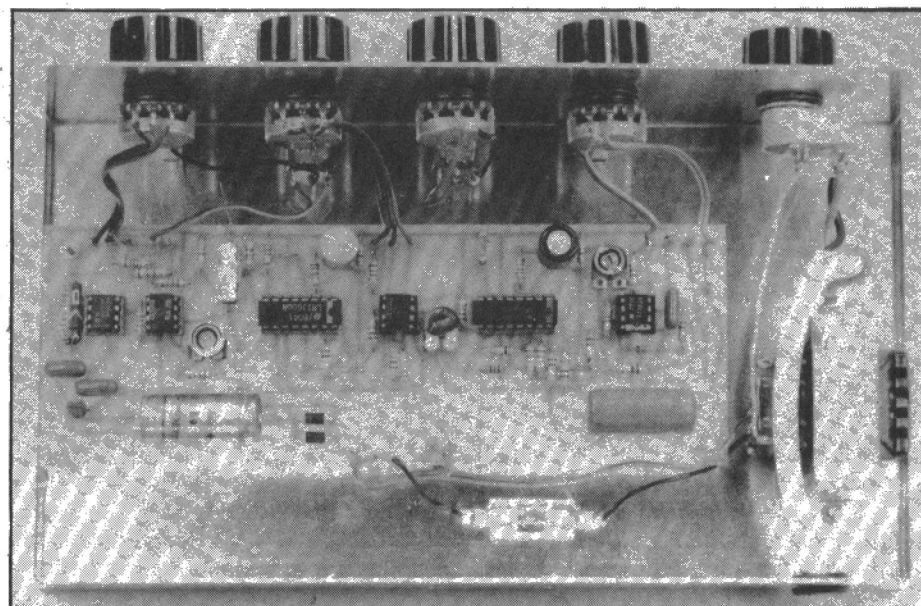


Figure 3. The basis of a log amplifier.



clipping circuit to round off the waveform to give the desired shape. In this circuit a soft clipping circuit is used, and one of the oscillographs shows the effect of this circuit. A buffer stage is used at the output of the unit to give a low output impedance.

Although it might at first appear that controlling the V.C.O. from a linear ramp (sawtooth) signal would give acceptable results, this is not in fact the case. The V.C.O. has an almost linear relationship between control voltage and output frequency, and the output frequency would therefore increase in a linear fashion using a linear ramp waveform as the control signal. Audio frequency response graphs are normally drawn with a logarithmic frequency scale so that (for example) 50Hz to 100Hz occupies the same space as 500Hz to 1kHz and 5kHz to 10kHz. Using a logarithmic frequency scale rather than a linear one gives results that are much clearer and easier to interpret, and ideally a sweep oscillator should have a logarithmic frequency scale.

A suitable sweep waveform is obtained by first generating a linear sawtooth waveform and then feeding this to a logarithmic amplifier which provides suitable shaping of this signal. One of the accompanying oscillographs shows the processed and unprocessed ramp waveforms.

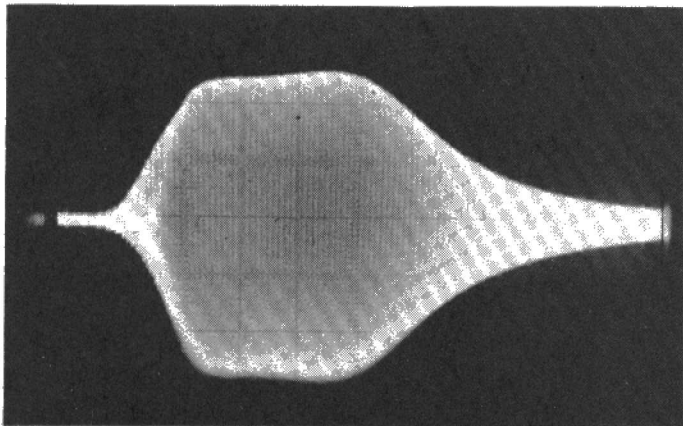
An amplifier is used to boost the output from the logarithmic amplifier to a suitable level, and this represents a convenient point in the unit to add frequency and sweep width controls.

The Circuit

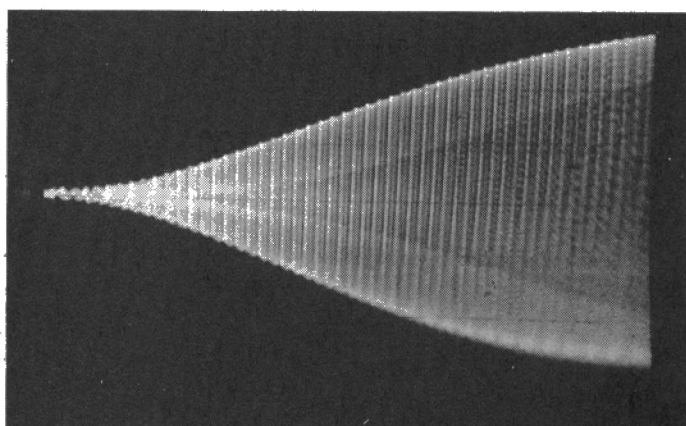
Figure 2 shows the circuit diagram of the ramp generator, logarithmic amplifier, and amplifier stages of the unit.

The ramp generator uses what is almost the standard triangular and squarewave generator circuit with IC1a acting as the integrator and IC1b operating as the trigger circuit. However, the inclusion of D1 in the charge path of C1 results in C1 charging almost instantly, giving a sawtooth waveform rather than a triangular output at the output of IC1a. RV2 controls the discharge time of C1 and acts as the sweep frequency control. This gives a frequency range of approximately 0.2Hz to 10Hz. The output waveform IC1b is a brief positive pulse, and this is used as the trigger signal for the sweep generator of the oscilloscope. The output from IC1a could be fed to the X input of the oscilloscope, but there could be problems in interfacing this signal to the X input. Using the triggered sweep method of operation should give good results with virtually any oscilloscope and is not difficult to set up.

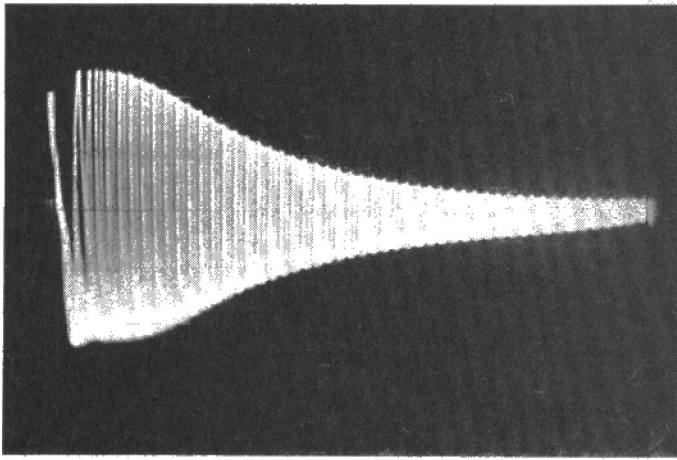
IC2 is a dual transconductance



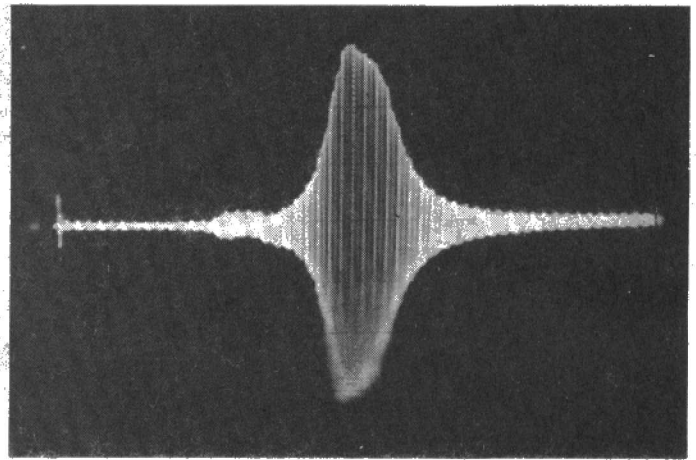
The response of a speech processor having high and low pass filters.
June 1983 Maplin Magazine



The response of a 6dB/octave high pass filter.



The response of a 6dB/octave low pass filter.



The response of a narrowband bandpass filter.

operational amplifier, but in this circuit both amplifiers are fed with fixed bias currents and are used as straightforward operational amplifiers. These are used in the logarithmic amplifier, and Figure 3 shows the basic circuit which is invariably used in amplifiers of this type. This is simply a forward biased silicon diode, and this provides an output voltage of about 0.6 volts or so provided the input voltage is at about this figure or higher. Although this circuit is often used as a simple voltage stabiliser there is some change in output voltage with variations in input potential. In fact, raising the input voltage by a factor of ten gives an increase in the output voltage of about 100 millivolts, and successive increases in the input potential give an almost identical rise in the output voltage.

This gives a good logarithmic response, but the gain of the circuit is reducing with increased input voltage, whereas this application requires a circuit which gives increased gain with rising input potential. The necessary transformation is obtained by using the resistor and diode in the negative feedback circuit of an amplifier. In this

case R6 is the resistor and the diode is actually the emitter - base junction of what would normally be the Darlington Pair output buffer stage of IC2a.

Apart from bias current, the voltage across a forward biased semiconductor junction also varies significantly with changes in temperature, and the logarithmic amplifier incorporates a temperature compensation circuit to minimise drift. IC2b and its Darlington Pair are used to provide this temperature compensation, and excellent results are obtained since the amplifier and compensation components are on the same chip and are therefore maintained at the same temperature.

IC3a is used as a simple inverting amplifier which boosts the output from the logarithmic amplifier by a factor of just over three times. IC3b is used as an inverting amplifier which converts the negative ramp output of IC3a back to the required positive ramp signal. The closed loop voltage gain of IC3b can be varied from unity with RV4 at minimum value down to a loss of over 20dB with RV4 at maximum value, and this enables the sweep range to be adjusted. S1 enables the ramp signal to be disconnected from the V.C.O. so that

the oscillator can be used at a fixed frequency which is set using frequency control RV5.

V.C.O. Circuit

The circuit diagram of the V.C.O., waveform shaper and output stages of the unit are shown in Figure 4. The V.C.O. uses IC4a to charge and discharge C5 at a constant rate, and IC4b is used as a trigger circuit. The charge and discharge current of C5 (and the operating frequency of the V.C.O.) is controlled by the bias current fed to pin 16 of IC4a. A resistor is used in series with this input so that voltage rather than current controlled operation is obtained, and this resistor is fed from the output of IC3b. The V.C.O. provides two output waveforms; a roughly squarewave signal at the output of IC4b, and a good quality triangular waveform at the output of IC4a.

It is the triangular waveform that is used in this application, and it is fed to IC5 which is used as a triangle to sinewave converter. IC5 is another operational transconductance amplifier, and it is used here as a fixed gain amplifier which is overdriven by the triangular input signal. Unlike most

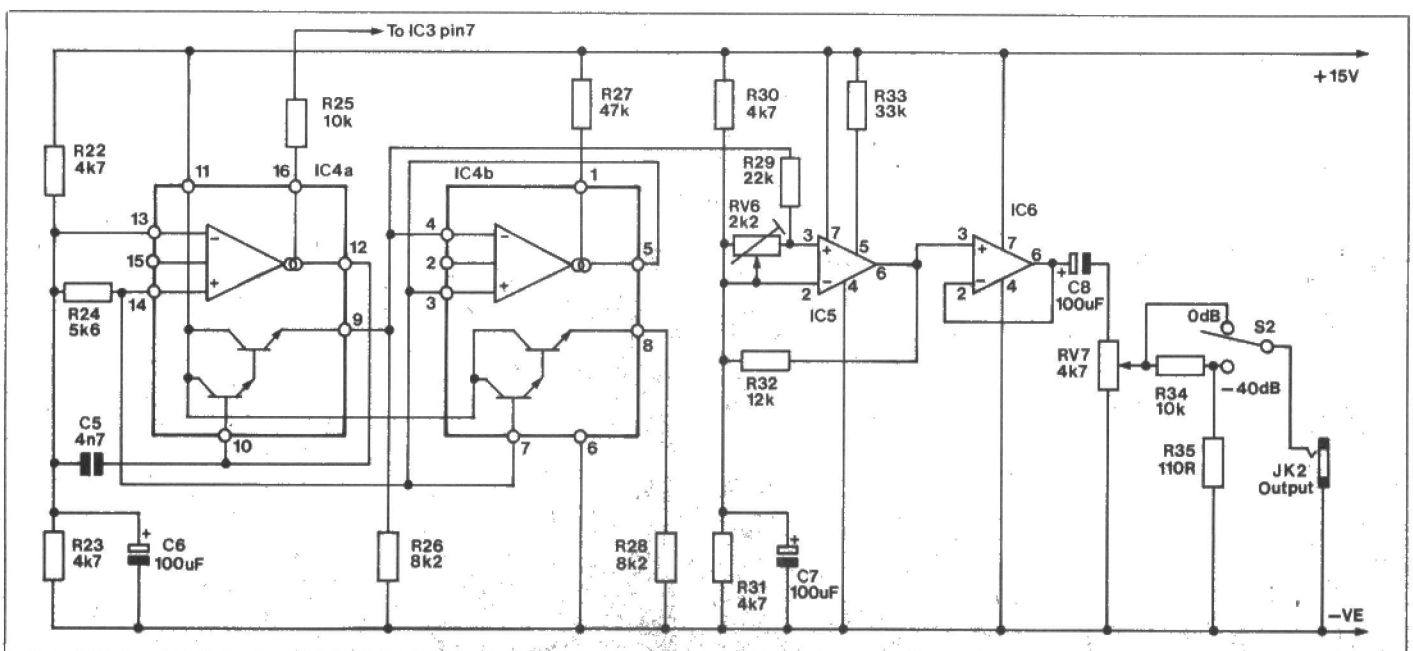
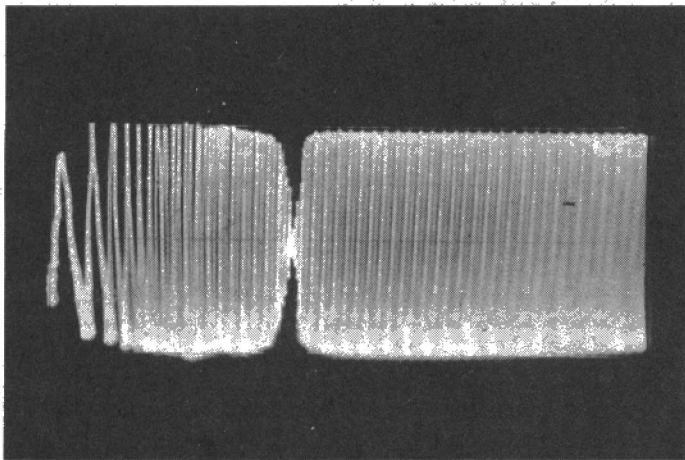
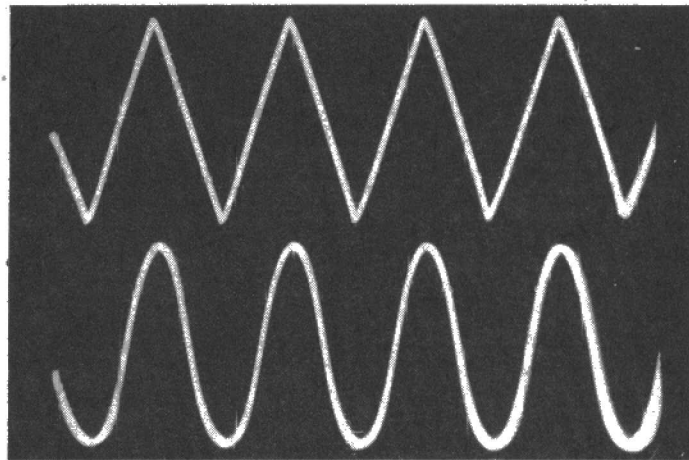


Figure 4. The VCO, waveform converter, and buffer amplifier circuits.



The response of a notch filter.



Top: The triangular output of the V.C.O.
Bottom: Output of the triangle/sine converter.

amplifiers, which provide hard clipping, an overdriven transconductance amplifier gives soft clipping, and in this case gives the required rounding of the input signal. RV6 is adjusted to give the best possible output waveform.

As the output impedance of IC5 is fairly high, IC6 is used as a straight forward unity gain buffer stage at the output. RV7 is the output level control, and S1 can be adjusted to reduce the output signal by about 40dB (by a factor of one hundred times). This makes it easier to adjust RV7 for very low output levels. The maximum output signal level is approximately ten volts peak to peak.

Mains P.S.U.

The unit requires a supply voltage of between about 12 and 18 volts, and a suitable 15 volt stabilised power supply circuit is given in Figure 5.

This is a straight forward circuit using a push-pull rectifier and a three terminal monolithic voltage regulator. A small (100mA) voltage regulator is more than adequate since the supply current is only about 15mA. C9 is the smoothing capacitor and C10 plus C11 are needed to aid the stability of voltage regulator IC7.

Construction

A metal instrument case which has approximate outside dimensions of 229 by 133 by 63.5mm is ideal for this project. The general layout of the front panel can be seen from the photographs, and the final wiring of the unit will be more straight forward if this layout is not radically altered.

Apart from T1, FS1, and the components fitted on the front panel, the components are all mounted on a printed circuit board, as detailed in Figure 6. Construction of the printed circuit board is mostly straightforward, but be careful not to omit the link wire (next to R28). Also, IC3 has a MOSFET input stage, and this device should therefore be fitted in a socket, and should not be plugged into circuit until the board is in other respects complete. Fit Veropins to the board at points where connections to the controls and other off-board components will eventually be made.

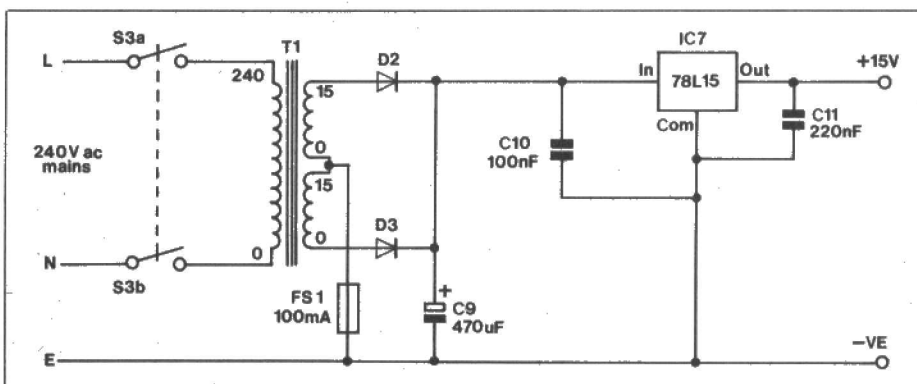


Figure 5. Mains power supply circuit.

The completed board is mounted on the base panel of the cabinet, on the right hand side, leaving space for T1 to be mounted on the left side of the unit with the fuseholder for FS1 to the rear of the board. The component panel is mounted using one inch 6BA bolts plus 1/2 inch 6BA spacers. The fuseholder for FS1, and T1 are both mounted using 1/4 inch 6BA bolts. The mountings screws for the top and sides section of the case protrude about 1/2 inch into the case, and T1 must be positioned where it will not obstruct one of these fixing screws.

An entrance hole for the mains lead is made in the rear panel of the case near to T1, and this hole is fitted with a small grommet.

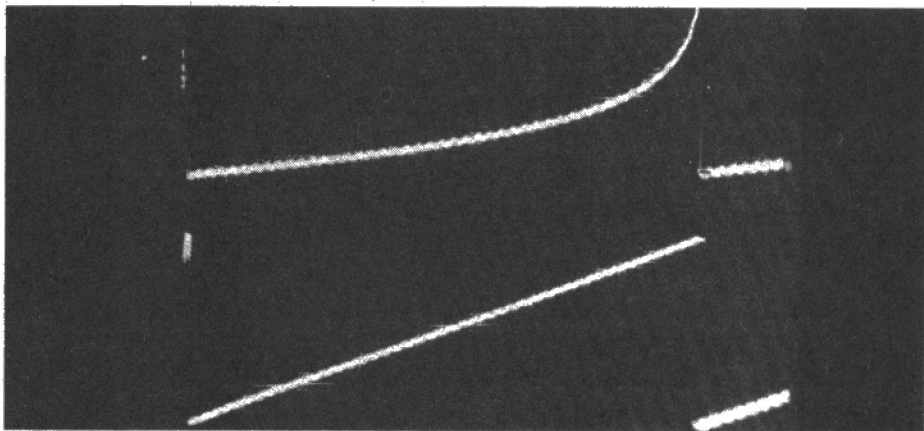
Figure 7 shows the point-to-point wiring of the unit. The identification letters in Figure 7 correspond with those in Figure 6, so that point 'A' in Figure 6 connects to point 'A' in Figure

7, point 'B' connects to point 'B', and so on.

Adjustment

Thoroughly check all the wiring before initially testing the unit, paying particular attention to the wiring around T1, S3 and FS1. Start with all three preset resistors at a roughly mid-point setting.

If an oscilloscope is used to monitor the signal at pin 12 of IC2 a non-linear ramp waveform should be present. If clipping of the signal is evident RV1 should be backed-off slightly in an anticlockwise direction so as to eliminate the clipping, but it should not be turned back much further than is absolutely necessary. If no clipping is evident, advance RV1 as far as possible in a clockwise direction without clipping being produced.



Top: Processed ramp signal.
Bottom: The linear ramp signal.

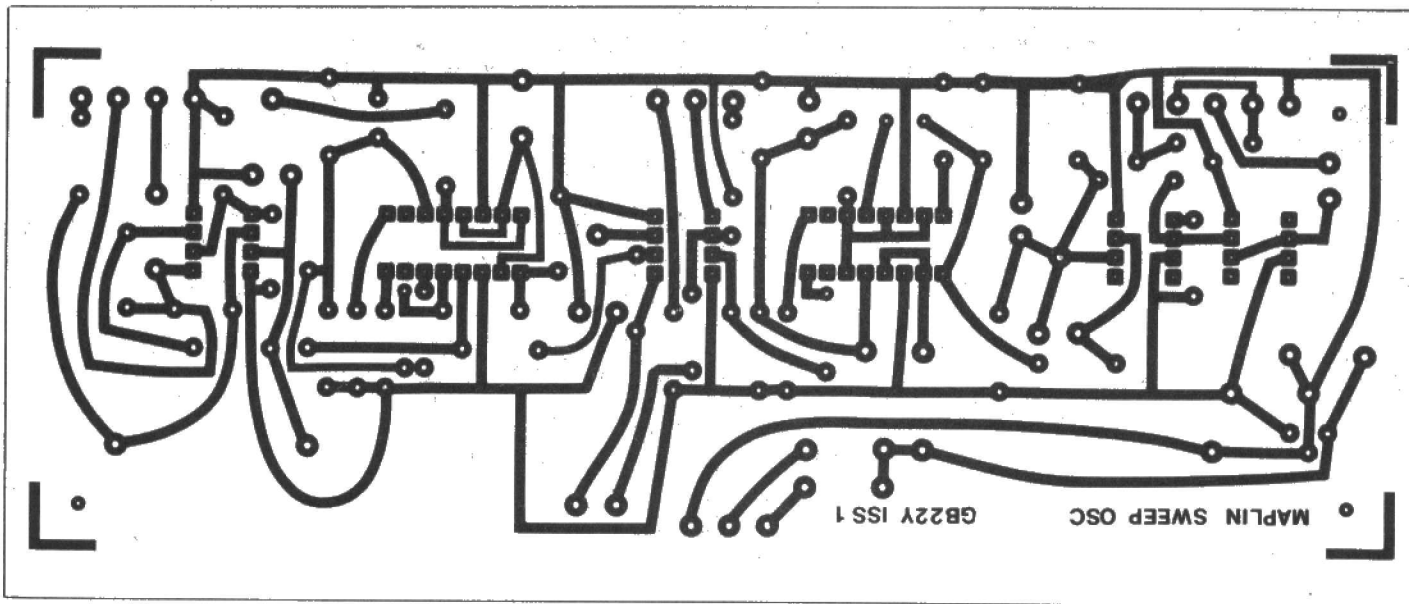


Figure 6. Legend and artwork.

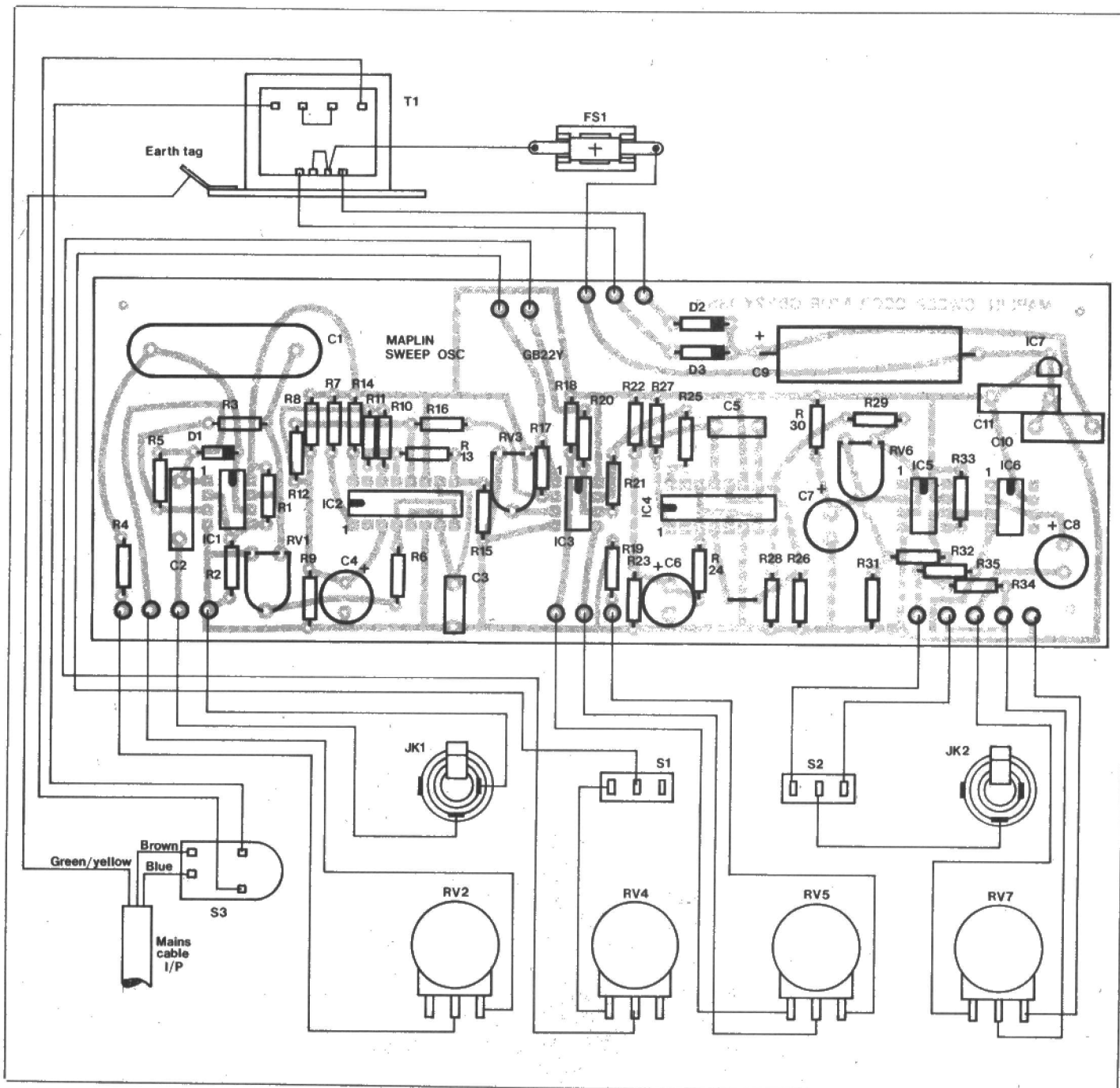


Figure 7. Wiring diagram.

RV3 is given a setting that gives an unclipped output signal at pin 7 of IC3, and the setting of this component will probably not be very critical.

With S1 set to cut off the V.C.O. from the ramp generator circuit so that a fixed output frequency is obtained, an oscilloscope is used to monitor the output waveform of the unit and RV6 is adjusted for the optimum output waveform. Alternatively a crystal earphone can be plugged into SK2 so that the output of the unit can be monitored by ear, and with RV5 set for a fairly low operating frequency it should be possible to hear the fundamental frequency plus the harmonics at higher frequencies. RV5 is then adjusted to minimise the harmonics.

Normally the unit will probably be used to cover the whole audio frequency over each sweep, and this requires RV4 to be set for maximum sweep range, or very nearly so (i.e. set in a fully clockwise direction). RV5 must

be set so that the unit is swept over the appropriate range of frequencies, and it is helpful here to use a slow sweep speed and to monitor the output of the unit using an earphone.

SK1 is coupled to the trigger input of the oscilloscope, and if the latter has a positive/negative trigger switch this should be set to the "positive" position. SK2 is coupled to the input of the equipment under test, and the output of this equipment is coupled to the Y input of the oscilloscope. S2 and RV7 are adjusted to give a suitable input signal level for the equipment under test, and the Y gain control(s) of the oscilloscope are set for a satisfactory trace height. A sweep speed of about 1HZ is suitable, and RV2 must be adjusted to match the sweep rate of the oscillator to that of the oscilloscope with reasonable accuracy. There is no real advantage in using a sweep frequency of less than about 1HZ. It is not advisable to use a higher sweep frequency since this would re-

sult in the oscillator being swept over the low frequency range before there had been any significant output at these frequencies, and misleading results would consequently be produced. A higher sweep frequency can be employed if the unit is only being used at output frequencies of a few hundred Hertz or more.

For detailed investigation over only a small section of the audio frequency band RV4 is backed off in an anti-clockwise direction and RV5 is adjusted to give coverage of the appropriate section of the audio spectrum.

Most oscilloscopes have a green medium persistence cathode ray tube, and with the low sweep speeds used in this application the left hand section of the trace fades out before the right hand portion is completed. Despite this the shape of the trace can be seen quite clearly without having to resort to a storage oscilloscope of some kind or oscillographs.

SIMPLE SWEEP OSCILLATOR

Resistors — All 0.4W 1% metal film

R1,2,8,9,22,23

30,31

R3,7,13,14

R4,27

R5,12

R6,10,11,15,32

R16

R17

R18

R19

R20,21,25,34

R24

R26,28

R29

R33

R35

RV1

RV2

RV3

RV4

RV5

RV6

RV7

Capacitors

C1

C2

C3

C4,6,7,8

C5

C9

C10

4k7

100k

47k

120k

12k

1M2

3M9

68k

1k5

10k

5k6

8k2

22k

33k

110R

4k7 min horiz preset

2M2 lin pot

22k min horiz preset

100k lin pot

47k lin pot

2k2 min horiz preset

4k7 lin pot

2u2 polyester

10nF polyester

1nF carbonate

100uF 10V radial elect

4n7 carbonate

470uF 25V axial elect

100nF polyester

all 220kF POLYESTER

CORRECTIONS FROM Vol 2 No. 8

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(2 off)

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Semiconductors

D1

D2,3

IC1

IC2,4

IC3

IC5

IC6

IC7

Miscellaneous

S1,2

S3

T1

SK1,2

FS1

1N4148

1N4002

LF353

LM13700N

CA3240E

CA3080E

741C (8 pin DIL)

uA78L15AWC

Min SPDT toggle

Rotary mains switch

Mains primary, twin 15 volt

200mA secondaries

3.5mm jack sockets

20mm 100mA quick-blow

Printed circuit board

20mm chassis mounting fuseholder

Case type WB4

Knob type K7B

8 pin DIL socket

13A mains plug

Min mains cable 2m

Hook-up wire black

Cabinet feet

Grommet small

Spacer 6BA 1/4in

Bolt 1/4in 6BA

Bolt 1/4in 6BA

Nut 6BA

Tag 6BA

Veropins type 2145

(2 off)

(2 off)

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(QL80B)

(QL74R)

(WQ31J)

(YH64U)

(WQ21X)

(YH58N)

(QL22Y)

(QL27E)

(FH00A)

(FH57M)

(WB15R)

(HF82D)

(WR00A)

(GB22Y)

(RX49D)

(LH39N)

(YX02C)

(BL17T)

(RW67K)

(XR01B)

(BL00A)

(FW19V)

(FW59P)

(FW35Q)

(BF05F)

(BF07H)

(BF18U)

(BF29G)

(FL24B)

A complete kit of all parts, excluding the case, is available for this project.

Order As LK06G (Sweep Oscillator Kit). Price £18.95.

6502 Machine Code Programming from page 7

What, for example, do you make of the number (yes, number!) DEAD?

If you followed what went before, you will realise that this is simply equal to:

$$\begin{aligned} & (D \times 16^3) + (E \times 16^2) + (A \times 16^1) + (D \times 16^0) \\ &= (13 \times 16^3) + (14 \times 16^2) + (10 \times 16^1) + \\ & \quad (13 \times 16^0) \\ &= 53\,248 + 3\,584 + 160 + 13, \\ &= 57\,005 \text{ (denary)}. \end{aligned}$$

HEX numbers can always be converted to denary in this way but, to make life a bit easier, Table 1 is included.

Conversion from binary to HEX is very easy. The golden rule is as follows — 'starting from where the binary point would be, divide the binary number into four-bit groups; convert each four-bit group into a separate HEX digit'. If you find that the 'highest' group doesn't have four bits, include zeros to make it up, if it helps to see the corresponding HEX digit more easily.

For example, consider the binary number

10110111. This 'byte' divides into two 'nibbles' (as half-bytes or four-bit groups are called).

Thus, we have 1011 0111. Now all you have to do is consider these as if they were BCD (Binary Coded Decimal) groups, write down the denary equivalent and, from this, the HEX equivalent. Of course you can miss out the denary stage and write HEX straight away if you wish, but you may need practice to do this consistently and without error. The two groups are seen to be equal to 11 (denary) and 7 (denary) respectively. Since 11 (denary) = B (HEX), the binary number 10110111 is written as B7 in HEX.

To take one further example to emphasise the point, take the case of the Stack Pointer Register mentioned earlier. It was said, in effect, that this could point to any address in the range 0100 to 01FF. However, the register itself has only nine bits, the 9th bit being permanently SET. Obviously the eight bits b0-b7 can take up any values in the range 00000000 to 11111111 (in binary),

while b8 is always '1'. Therefore, the contents of the Stack Pointer Register must lie between the limits:

$$\begin{aligned} & 0001\,0000\,0000 = 100 \text{ (HEX)} \\ & \text{and } 0001\,1111\,1111 = 1FF \text{ (HEX)} \end{aligned}$$

Note that three zeros have been added to the highest bit to complete this nibble and, since addresses are usually written with four HEX digits, another nibble of four zeros should be added to the left to give the address range as 0100 to 01FF, as previously stated.

If machine-code programming was something entirely new to you, then perhaps this article has given you enough to think about for the time being. For anyone who cannot wait to find out more, I suggest they buy one of the several 6502 programming manuals available; it would be a good idea anyway for the serious programmer. My personal preference is for 'Programming the 6502' by Rodney Zaks from Sybex, but at the time of writing it is about £10.50.

ZX81/MODEM INTERFACE

ZX81/MODEM INTERFACE

ZX81/MODEM INTERFACE

- ★ Connects ZX81 to Modem or other computers
- ★ TTL/RS232 compatible
- ★ Plugs into expansion socket via motherboard
- ★ 300 Baud standard transmission rate (adjustable)

by Dave Goodman

The immense popularity of our Modem project has prompted us to develop a series of connecting interfaces for most of the popular home microcomputers. This will enable two-way communication, either direct to other computers or via telephone links to systems such as the Maplin on line computer.

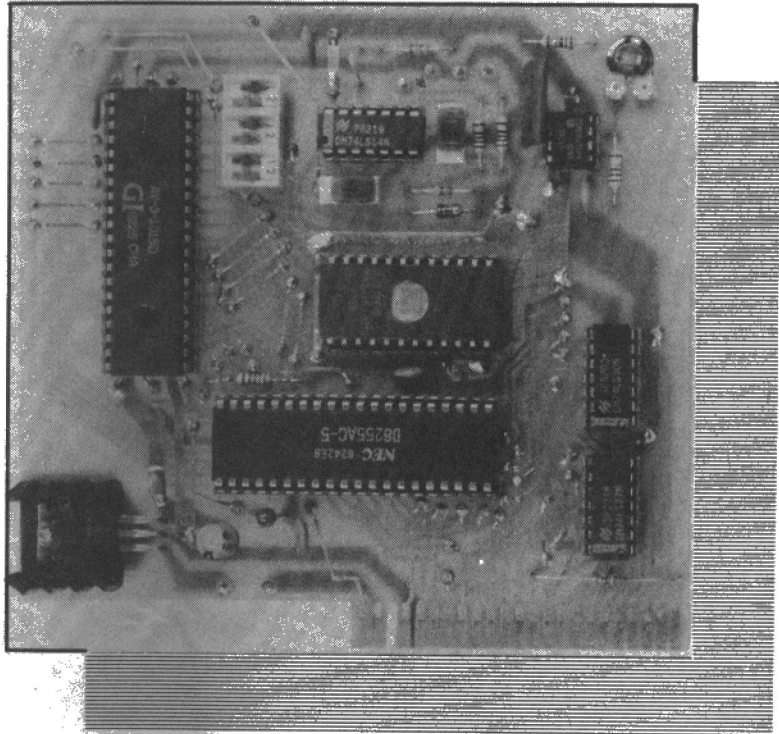
The ZX81/Modem interface utilises an EPROM code translator for converting ASCII coded signals to ZX code and vice versa, as the ZX81 is not ASCII coded.

Included in the article is a machine code program for running our interface with the ZX81. Perhaps the thought of machine code programming is anathema to many Sinclair BASIC users, but don't be put off. All that you need to do is type in the codes given, store the program on tape for future use, and RUN. If you so wish, the program can be used as a basis for further development by the more experienced programmer.

Circuit Description

REG 1 is fitted so that the power supply can be taken from the unregulated side of the computer PSU (+9V). This saves undue loading on the internal regulator of the ZX81, and, if link 1 is not used, any external supply of +8V to +30V may be connected to P2 instead.

Serial data transmissions enter the UART (IC6) via level change triggers from pin 3 and 6 (OV). All signals are TTL level, and may be connected direct or inverted by S7 to suit the system. IC7 is a 4.8kHz astable multivibrator, and supplies the UART, which needs a clock frequency of sixteen times the required Baud rate. Dividing 4800Hz by sixteen will give the standard Baud rate of 300.



Receive Mode

The I/O port IC3 has three ports designated A, B, and C. For the computer to access these ports it is necessary to make room in the memory map, so that IC1 and IC2 decode address lines A3 to A15 for addresses 8312 to 8315, which appear in the 'ghost' ROM area in the ZX81. D1 deselects the internal ROM area for use by the interface. IC3 is an 8255, which has quite a comprehensive operating instruction set, but for our application all that is necessary is to set Port A to output mode, Port B to input mode, Port C upper (pins 10 and 11) to input mode, and Port C lower (pins 14 to 17) to output mode.

To do this a control code must be placed on the computer D0 to D7 data lines at address 8315, and the control code to set the mode is 138. Of course,

setting the control code must be done immediately at the beginning of programs used to control the port, and would be something like POKE 8315, 138.

Port C, address 8314, is set next to disable the EPROM output (OE HIGH-IC4), and prevent IC6 from transmitting data DS HIGH and setting RDE low. This allows data from IC6 to be placed into Port B (address 8313). The DAV (data available) output goes high when serial data enters IC6, and this acts as a FLAG to tell the computer that information is ready to be read from Port B.

Unfortunately, the ZX81 code system is not compatible with ASCII, so received CHR\$ will need to be translated. Port B is read and this data is placed into Port A (address 8312) and EPROM IC4, where it is translated and

ZX81/MODEM INTERFACE

ZX81/MODEM INTERFACE

ZX81/MODEM INTERFACE

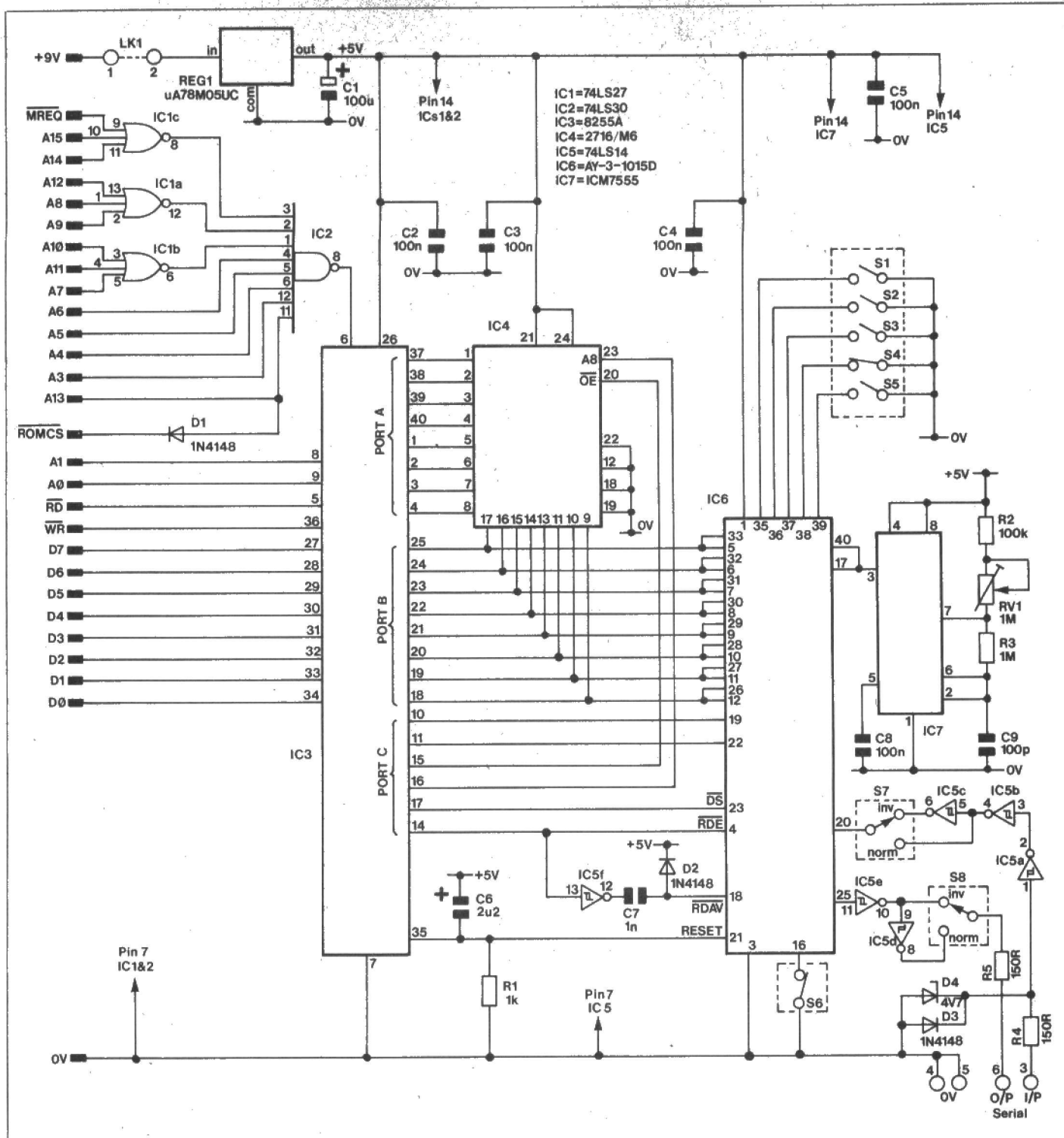


Figure 1. Circuit diagram.

placed into Port B again. Reading Port B will produce the required character for printing to the screen display. Using an EPROM for code translation makes programming much simpler and reduces memory requirements, although IC4 could be omitted and data read from Port B direct. This arrangement would be used when communicating with another ZX81.

Transmit Mode

Port C is used to reset the DAV output via IC5. Disable the receive data lines P5 to P12 by taking RDE high, hold IC4-A8 high (this address line must be high for Tx codes and low for Rx codes) and enable IC4 output by taking OE low. ZX codes for transmitting are then placed into Port A and IC4, and hence to

the UART. DS (transmit data strobe) is taken low, to latch data from pins 26 to 33 into IC6, then DS is taken high to transmit data in serial form via IC5, S8, to pins 6 and 4 (0V).

Switches S1 to S6 set various status bits, character length and parity as shown in Tables 1a and b. Switches S7 and S8 allow the user to select either normal or inverted signals for receive or transmit, depending on the system connected. R1 and C6 reset both UART and I/O port when first switched on, and D2 and C7 apply a fast negative pulse for resetting DAV output.

Switch	Closed	Open
1	parity	no parity
2	one stop bit	two stop bits
5	odd parity	even parity

Table 1a.

Bits per character	Switch 3	Switch 4
5	closed	closed
6	closed	open
7	open	closed
8	open	open

Table 1b.

A standard switch setting would be switches 1, 2, 3, and 5 open and switches 4 and 6 closed. This gives 7 bits per character, 2 stop bits and no parity. S6 would normally be left closed, as this places all status bits onto the output lines.

Address	Description	Function
8315	Control address	Data 138 — set mode
8314	Port C	Lower output — Upper input
8313	Port B	Input only
8312	Port A	Output only

Table 2. All Port addresses and their functions.

Construction

Start construction by fitting all 83 track pins. They are inserted through the holes in the PCB marked with a circle. Press them home and apply solder to both sides of the board. Next fit the five resistors and four diodes. Around one end of the diode body is a black band, and this should be lined up with the white bar on the PCB legend.

Now place all seven IC sockets in position. ICs 3 and 6 use 40-pin sockets, IC4 uses a 24-pin socket, ICs 1, 2, and 5 use 14-pin sockets, and IC7 uses an 8-pin socket. Solder these into place to prevent them falling out whilst you are completing the assembly.

Insert the DIL switches S1 to S6. They are of dual construction, and have two switches per package. Each switch is operated by moving one of the plastic arrows on the top, the numbers 1 and 2 being the 'on' position. The arrow crossbar is shown on the PCB legend to assist with correct orientation. Switches S7 and 8 are of a different construction, being the changeover type of switch, and these have a large plastic cap on top with three small arrows. Again, the legend will assist you in locating these components.

Insert the disc and plate ceramic capacitors. C9 is a silver mica type, and, being much larger than the others is easily recognised. When fitting C1 and 6 ensure correct polarity. Preset RV1 can now be fitted, as can the six veropins. Finally, insert a 1/2in 6BA bolt through the PCB, from the track side, and place a vaned heatsink in position over it. Mount REG 1 onto the heatsink, ensuring that the bolt goes through the mounting tab on the regulator body. No mounting kit or silicon compound is necessary here. Use a 6BA washer and nut to clamp REG 1 to the heatsink and PCB. All three leads can now be bent and inserted through the board for soldering. Solder all components carefully in place, cut off the excess leads and inspect for bad joints and short circuits.

Scrubbing excess flux from the track, using thinners and a stiff brush,

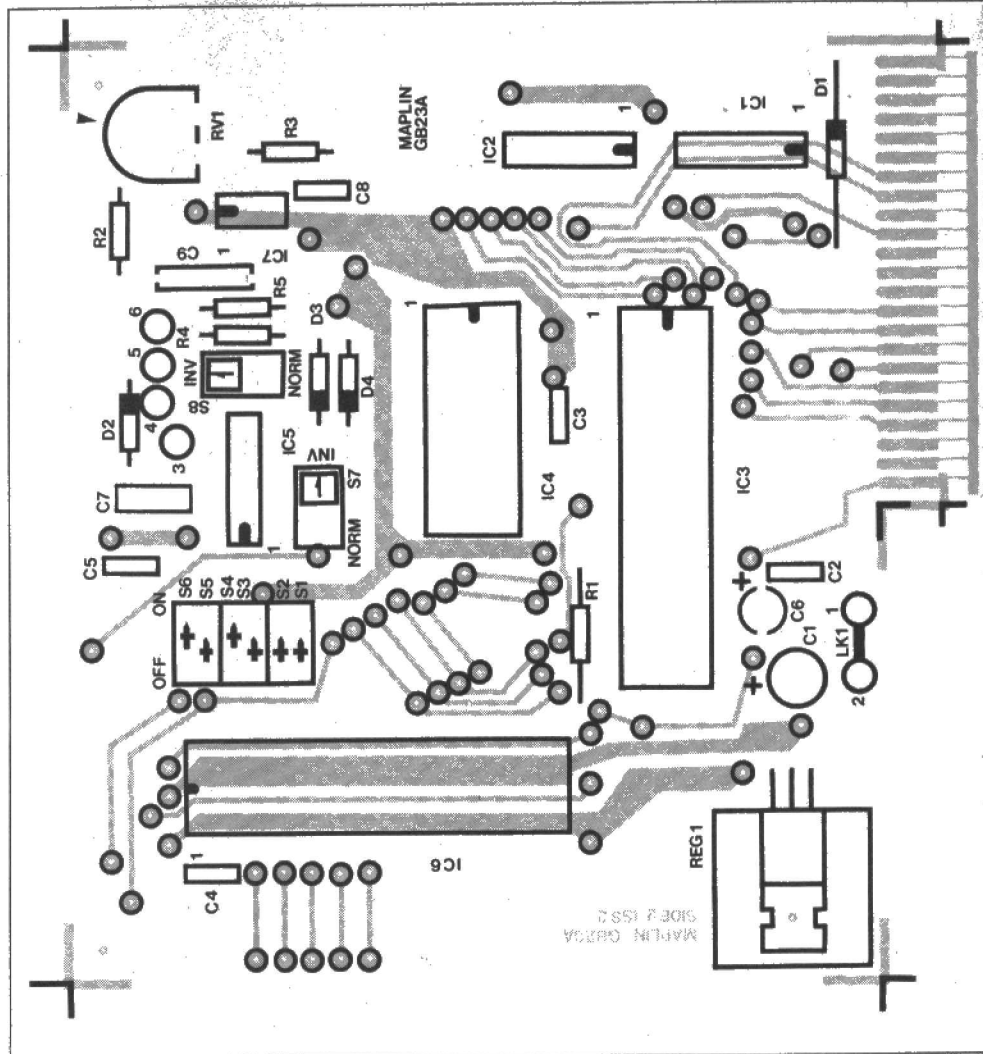


Figure 2. PCB legend and artwork.

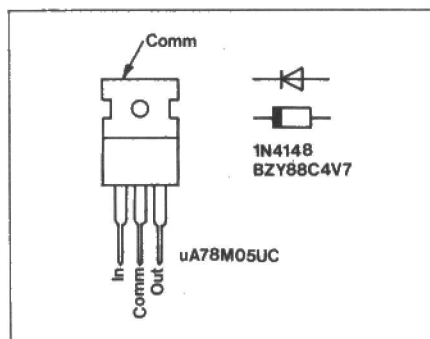


Figure 3. Pinouts.

will make inspection easier and often remove solder blobs and whiskers otherwise overlooked.

Testing

Do not insert any ICs at this stage. Solder a connecting wire between pins 1 and 2, set RV1 wiper with its centre pointing to the arrow legend on the PCB. Set S4 to 'on', that is with the brown arrow at 1, and also set S6 to 'on'. Switches 1, 2, 3, and 5 are set to the 'off'

```

1 PRINT TAB 6; "RECEIVE CODES"
2 LET T = 0
3 LET H$ = "0123456789ABCDEF"
4 POKE 8315, 138
5 POKE 8314, 9
10 FOR I = 0 TO 255
15 PRINT AT 9,5; "ADDRESS DEC HEX"
20 POKE 8312, I
25 LET P = PEEK 8313
30 PRINT TAB 7; I+T; TAB 14; P; " "; TAB 19;
35 PRINT H$(1+INT(P/16));H$(1+P-(16*INT(P/16)))
40 NEXT I
45 IF T = 256 THEN STOP
50 CLS
55 PRINT TAB 6; "TRANSMIT CODES"
60 LET T = 256
65 POKE 8314, 13
70 GOTO 10

```

Program 1.

```

5 REM TEST PROGRAM 2.
10 LET CW=8315
15 LET C=8314
20 LET B=8313
25 LET A=8312
30 POKE CW, 138
35 POKE C, 15
40 IF INKEY$="" THEN GOTO 40
45 IF INKEY$="" THEN GOTO 45
50 LET W$=INKEY$
55 POKE A, (CODE W$)
60 POKE C, 13
65 POKE C, 5
70 POKE C, 15
75 IF PEEK C<128 THEN GOTO 75
80 POKE C, 14
85 POKE A, (PEEK B)
90 POKE C, 8
95 PRINT CHR$(PEEK B))
100 GOTO 40

```

Program 2.

ZX81 MODEM INTERFACE PARTS LIST

Resistors — All 0.4W 1% Metal Film.

R1	1k		(M1K)
R2	100k		(M100K)
R3	1M		(M1M)
R4,5	150R	2 off	(M150R)
RV1	1M Hor-sub. min. Preset		(WR64U)
Capacitors			
C1	100uF 10V PC Electrolytic		(FF10L)
C2-5 inc. 8	100nF Minidisc	5 off	(YR75S)
C6	2u2F Tantalum		(WW62S)
C7	1nF Ceramic		(WX68Y)
C9	100pF Silvered Mica		(WX13P)
Semiconductors			
D1,2,3	1N4148	3 off	(QL80B)
D4	BZY88C4V7		(QH06G)
REG 1	uA78M05UC		(QL28F)
IC1	74LS27		(YF18U)

IC2	74LS30		(YF20W)
IC3	8255A		(YH50E)
IC4	2716/M6		(QY52G)
IC5	74LS14		(YF12N)
IC6	AY-3-1015D		(WQ18U)
IC7	ICM7555		(YH63T)
Miscellaneous			
S1-6 inc.	DIL Switch SPST Dual	3 off	(XX26D)
S7,8	DIL Switch SPDT Single	2 off	(XX28F)
	8-Pin DIL Skt		(BL17T)
	14-Pin DIL Skt	3 off	(BL18U)
	24-Pin DIL Skt		(BL20W)
	40-Pin DIL Skt	2 off	(HQ38R)
	Vaned Heatsink		(FL58N)
	Bolt 6BA x 1/2"	1 Pkt	(BF06G)
	Nut 6BA	1 Pkt	(BF18U)
	Veropin 2141	1 Pkt	(FL21X)
	Track Pin	2 Pkts	(FL82D)
	PCB		(GB23A)

A complete kit of all parts is available for this project.
Order As LK08J (ZX81/Modem Interface). Price £24.95.

position, and switches 7 and 8 to 'INV'. With no power attached, plug the interface PCB into your ZX81 or Extended-board, and switch on. Use a voltmeter connected to OV (pin 4/5), and check for +5V on the output pin (right-hand side) of REG 1. Switch off, insert ICs and re-apply power. You should be rewarded with a cursor on the screen, as normal. If a frequency counter or oscilloscope is available, check for a 4.8kHz signal on pins 17 and 40 of IC6, and adjust RV1 to suit. When testing programs, note that on a 1K only machine the interface will still function, although you will not be able to run the machine code program and have a full screen display.

Now enter and run test program 1. This will test all port locations, along with the EPROM addresses 0 to 511. The display data, printed in decimal and hexadecimal, shows ASCII and ZX81 CHR\$ codes stored in IC4.

After typing the program enter RUN/NEWLINE. The program will stop after printing EPROM address 511; with an error 9 at line 45, which is all right. If, however, your test program fails before this make sure that you have entered all eighteen lines correctly. If you still have

problems the Port may be faulty, in which case you will need to POKE data into Port A and PEEK Port B to get an indication of the failure.

Next, enter and run program 2. Connect pins 3 and 6 together on the module, and press any key. Data will be transmitted and received, then printed on the TV display, proving that the module is functioning correctly. The display is limited to around 400CHR\$ in 1KB.

Using the Interface

As mentioned previously, the program and working system require a minimum of 1050 bytes of memory, which means that to display a full screen of data a RAM extension is required. You could, however, write a simple receive only routine, for testing your interface with modem systems, but BASIC is too slow for this application, so machine code programs become necessary. Program 3, entered into a REM statement, will allow two-way communication with the Maplin on-line computer, and also several other commercial data links. The TV display will be blank until data is received, whereupon the bottom line

will fill with characters and scroll when full.

Carriage return codes will scroll the display while line feed codes are trapped and not used. Once you have established a data link, transmission can be direct from the keyboard — no transmit or receive mode control codes are required here. Provided that systems connected to the interface have echo facilities, you may print to the screen via the transmission path, not directly from the keyboard. Many shift characters are valid, but some of them will be decoded as question marks, along with all the unused EPROM address codes.

Function and Graphics modes are not used, and should generate either shifted or direct key characters. Facilities do not exist for deleting characters or for clearing the screen. The BREAK key returns a space and NEWLINE gives carriage return when typing program 3.

Once the last character has been entered the program will stop running. Return to SLOW mode and press NEWLINE. You will see line 20 full of characters and symbols. Parts of the line will be blank due to code 118 being entered, but this is all right. Now check the data by changing line 40 to PRINT I, and line 50 to PRINT PEEK I. Now RUN 30 and a check list giving each address and the number stored there will fill the screen. To continue press CONT-NEWLINE.

When you are happy with your efforts RUBOUT lines 30 to 60 and type in line 30 LET A=USR 16524. The function USR is below key L, and 16524 is the starting address of the machine code program. You would be well advised at this stage to save 'MI' on cassette a few times. 'MI' is short for Modem Interface, although obviously any recognition code could be used. If line 10 REM statement length is increased, the starting address 16524 will also be increased, so you must calculate this when changing the program name, or all will be lost!

To operate the system, hook up the modem, or whatever you are trying to communicate with, to pins 3 (serial input), 4 (OV), and 6 (serial output), and load the program. Type RUN-NEWLINE and make the communicating link. You may now receive or transmit data as required.

```
10 REM "MI"
20 REM (Type in 110 full stops)
30 FOR I = 16524 TO 16632
40 INPUT A
50 POKE I,A
60 NEXT I
```

Go into FAST mode, press RUN then NEWLINE and enter the following Decimal codes.
(Enter each code then NEWLINE.)
Each code is a number between 0 & 255 inc.

```
62 138 50 123 32 205 14 12 14 0 33 122 32
54 11 54 10 126 230 128 40 28 58 121 32 254
10 40 237 50 120 32 54 9 58 121 32 254 118
40 220 215 62 32 12 185 40 213 24 216 229
197 237 75 37 64 33 255 255 167 237 66 40
40 17 0 1 167 237 82 40 32 205 189 7 126 237
75 37 64 33 255 255 191 237 66 32 244 50 120
32 33 122 32 203 118 40 252 54 13 54 5 54 10
193 225 191 24 164
```

Program 3.

CASHTEL — THE NEW WAY OF SHOPPING

Maplin's brand new Computer Aided SHopping by TELephone service (CASHTEL) opens on June 1st. After this date, the message currently available on 0702 552941 will be replaced by a real time computer order system.

After accessing the system you will be able to enter stock codes and check the current price and whether we have sufficient stock to meet your requirements. If you wish, you may then place an order. You will only be able to do this if you have already bought from us by mail order and have been allocated a Customer Number. Alternatively, please send or phone your name and address to us and we will allocate a number for you. A credit card is also necessary.

You will then be asked to enter your Customer Number and name and address. You must enter them exactly as they appear on the label on the order form returned to you. If what you enter matches what is on file, you will then be able to enter your order.

Type in the stock code and quantity of all the items you want. When this is completed, you will be asked for your credit card number (Access, American Express, Barclaycard or Mapcard). Note that goods will only be sent to the cardholders address as advised by the

credit card company.

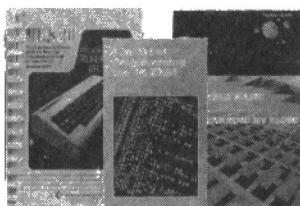
You will then be told exactly how much you will be charged and if you accept, when you hang up the order you have placed will be passed to the printer in our warehouse. A few minutes later your order will be collected, packed and despatched.

Any European standard (CCITT) 300 baud modem will be able to communicate with our computer. Our computer is a Digital Equipment (DEC) PDP11/70 with 2Mbytes of MOS memory and 200Mbytes of on-line disk memory. Although you will not notice (our computer's response will appear instantaneously), there will be around 36 other interactive users accessing the system at the same time you are.

If the main computer is not available, you will receive a message showing the times when Cashtel is operating. If you continually receive busy tone or have any operational problems, please telephone 0702 554155 and ask for the DP manager. If he is not available, please leave a message with the switchboard operator. This will help us to monitor the service and provide more lines if necessary.

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These are our top twenty best-selling books based on mail-order and shop sales during November and December 1982 and January 1983. Our own publications and magazines are not included. We stock over 450 different books relating to electronics or computing, and the full range is shown on pages 29 to 65 of our 1983 catalogue. For prices see page 29 of this magazine.

NEW ITEMS IN THIS ISSUE

BK74R	P.C. Edgecon 2 x 12 Way	Price £3.86
GB19V	DX'ers Audio Processor PCB	Price £1.90
GB21X	CMOS Crystal Calibrator PCB	Price £2.72
GB22Y	Sweep Oscillator PCB	Price £3.25
GB23A	ZX81 Modem Interface PCB	Price £4.75
GB24B	Enlarger Timer PCB	Price £1.40
GB28F	VIC20 RS232 Interface PCB	Price £2.90
LK05F	DX'ers Audio Processor Kit	Price £14.95

LK06G	Sweep Oscillator Kit	Price £18.95
LK07H	Enlarger Timer Kit	Price £27.50
LK08J	ZX81 Modem Interface Kit	Price £24.95
LK10L	Crystal Calibrator Kit	Price £15.95
LK11M	VIC 20/RS232 Interface Kit	Price £9.45
QY52G	2716/M6	Price £8.50
QY53H	BF173	Price £0.19

MANCHESTER SHOP OPENS SOON

Our new Manchester superstore offering the full range of Maplin's electronic components, computers and software will be opening in mid-August 1983. Part of the new store will be a self-service area where you can browse around and choose the parts you want. Counter service will be available as well. Upstairs you will find our computer demonstration area with displays of hundreds and hundreds of different software packages for Atari, BBC, Commodore 64, Dragon, Microprofessor, Sord M5, Spectrum and VIC20.

You will find us at 8, Oxford Road opposite the BBC, between Piccadilly and UMIST. We're just a few steps from Manchester's Oxford Road station and about five minutes walk from the city centre. There is excellent parking on meters in the adjacent sideroads and we're about five minutes drive straight in from junction 10 on the M63 at the start of the M56. We'll have more details for you in our next issue.

CORRIGENDA

Vol. 1 No. 2 Burglar Alarm

The value of C8 on the Main PCB is now 68nF (WW39N).

Vol. 1 No. 4 Remote Controller for Amplifier

In Figure 2, Pin 14 of IC1 goes to S2/6/5 (Note PCB is correct).

Vol. 2 No. 5 Modem

D9 Function is "LOCK"

D10 Function is "Tx DATA"

D11 Function is "Rx DATA"

D12 Function is "ON LINE"

On cct dia. IC10a & IC10c should be swapped (IC10a drives TTL O/P).

In Setting Up instructions, the signal at TR2 emitter should be a stepped sinewave of 800mV (not TR1).

On some PCB's the "+" sign of C33 is shown incorrectly, the positive should go the outside of the board.

Vol. 2 No. 6 VIC20 Talkback

In Parts List, C8 should be 10,000pF not "nF".

ZX81 Talkback

In text on page 8, second paragraph in the centre column "with suitable programming IC6 will place D0 to D8 to.....etc", should read "D0 to D7".

First Base

In text on page 21, in last sentence of paragraph before "CONSTRUCTION" heading, "D5" should be "LED 1".

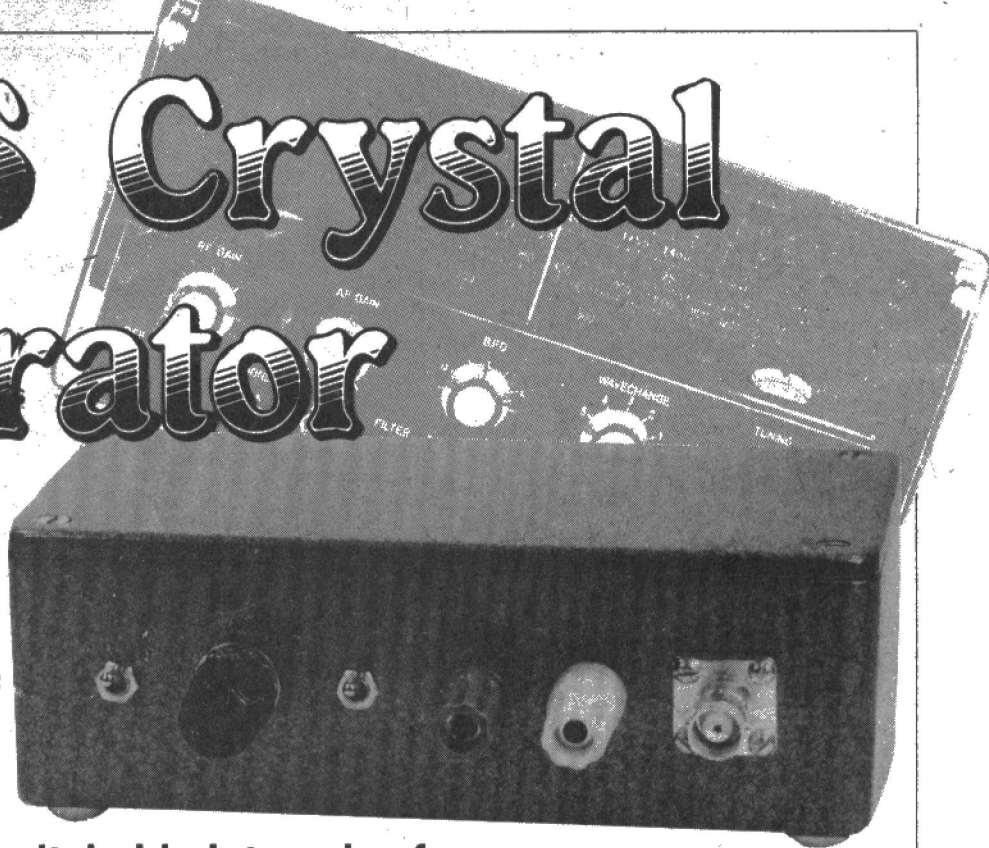
In Figure 10, on page 25, the value of D5 is "6V2".

In Figure 4, the arrows shown on D10 should be in the opposite direction.

COMING SHORTLY

I/O Ports for the Dragon 32 and Spectrum
TTL/RS232 Converter
1K RAM extension for the ZX81, which can be easily expanded up to 7K
Part 2 of the Telephone Exchange
VIC Extendiboard with an optional 3K RAM
An article on How to Interface the BBC Micro
Synchro unit to go with Synclock, Synwave and Syntom
Minilab project Doorbell for the Deaf
Electronic Codelock Logic Probe
Dragon/RS232 Interface

CMOS Crystal Calibrator



- ★ Enables calibration of receivers.
- ★ Checks the position of the edges of amateur band allocations.
- ★ Produces markers at switchable intervals of 1MHz, 100kHz, 12.5kHz, or 10kHz.

by A. J. Bell, BSc, GW4JJW

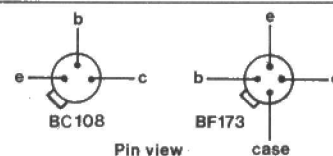
Introduction

This article describes a crystal calibrator designed around CMOS logic IC's, which produces markers switchable at intervals of 1MHz, 100kHz, 12.5kHz or 10kHz. When the calibrator was tested using a spectrum analyser, the markers were found to be complete to 300MHz - beyond this frequency they approached the spectrum analyser noise level. The markers can be amplitude modulated with a 1kHz tone, a facility which produces markers at 1kHz intervals. The current consump-

tion of the crystal calibrator is less than 3mA at 9V (27mW) - less power than would be consumed by a single 74-series TTL integrated circuit.

Operation

The circuit diagram of the crystal calibrator is shown in figure 1, and the various semiconductor pinouts and logical functions in figure 2. A stabilised voltage supply, comprising TR2 and D2, supplies power to all the CMOS logic. In order to reduce power consumption the zener diode is run at a lower current than normal. Three different zener



ADDRESS INPUTS			CONTROL INPUTS		OUTPUT
C	B	A	INHIBIT	OE	Z
0	0	0	0	0	x0
0	0	1	0	0	x1
0	1	0	0	0	x2
0	1	1	0	0	x3
1	0	0	0	0	x4
1	0	1	0	0	x5
1	1	0	0	0	x6
1	1	1	0	0	x7
-	-	-	1	0	0
-	-	-	-	1	Hi Z

- = Dont care. Hi Z = Tristate condition

Figure 2. Semiconductor pinouts and logic function chart.

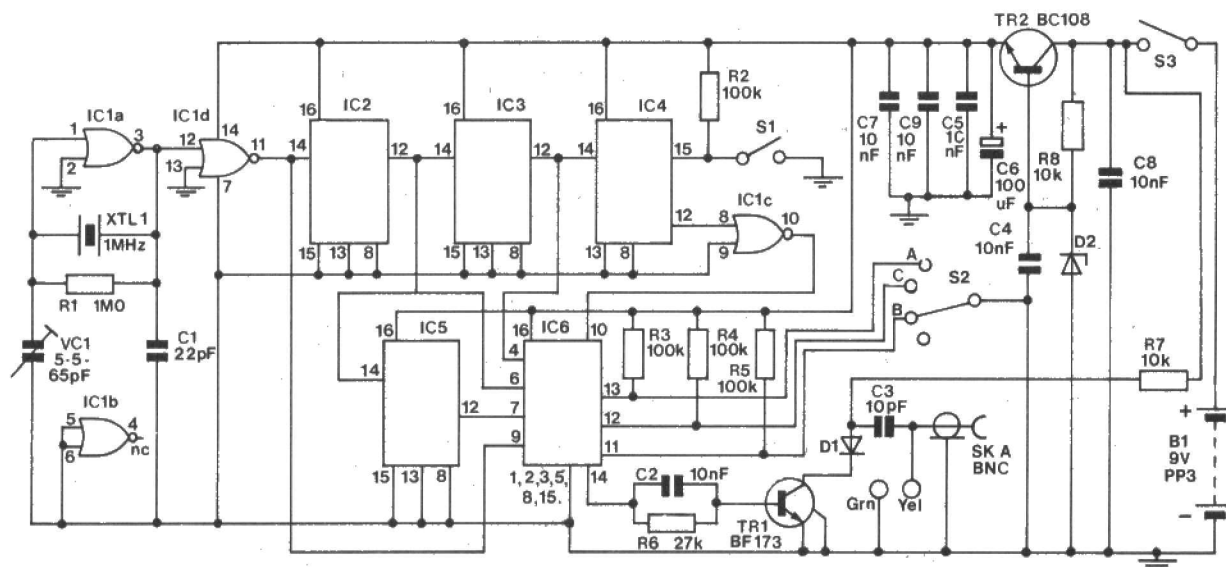


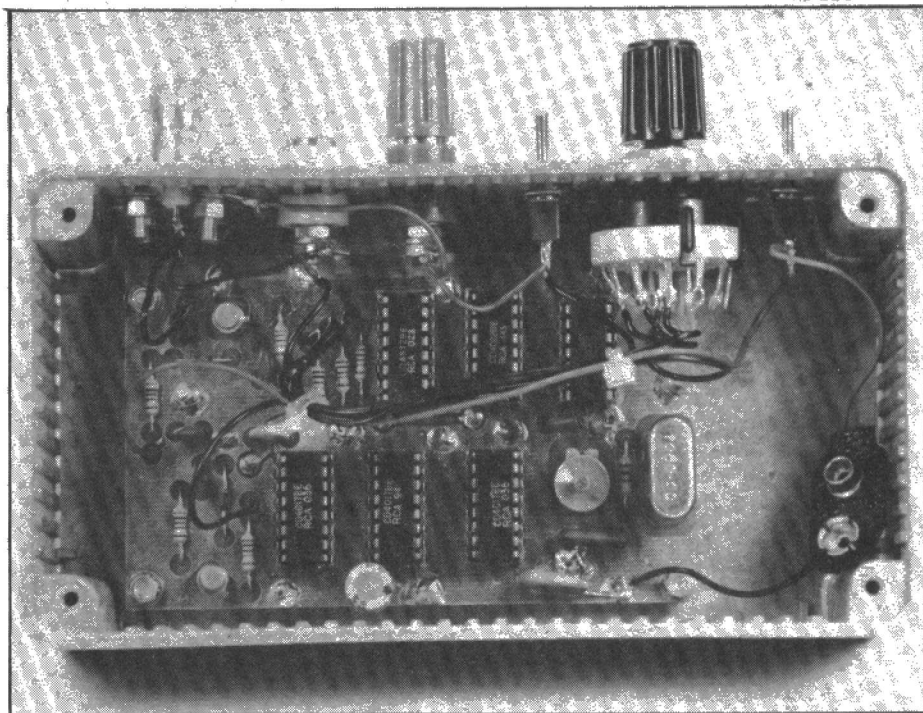
Figure 1. Circuit diagram.

diodes were tried under these conditions and all functioned satisfactorily. A single CMOS NOR gate (IC1a) is used as a 1MHz crystal oscillator, whose frequency may be trimmed using VC1. The output from the oscillator is buffered by another section of the NOR gate (IC1d) and then fed into a chain of dividers which produce frequencies of 100kHz, 12.5kHz and 10kHz. These, together with the original 1MHz, are fed into the data selector (IC6).

A "data selector" is a type of logic IC that selects only one of many inputs. The selection is performed according to the value set on its address line inputs. Figure 2 shows the logical functions of the data selector, type 4512, used in the crystal calibrator. It can be seen that if all address lines are high, data line "X7" will be selected. For the crystal calibrator, inputs X7, X6, X5 and X3 are used for the 1MHz, 12.5kHz, 100kHz and 10kHz signals respectively. These particular input lines were chosen because they can be selected by making none or any one of the address lines logical zero - this is the function of the interval switch SW2.

The use of a data selector allows the marker interval to be chosen by switching DC signal levels, instead of the standard method of switching the RF signals directly. This keeps the lengths of the wire carrying RF to a minimum, thereby reducing radiation or pickup.

When SW1 is closed, IC4 is freed from its reset state and produces a 1kHz signal which is inverted by IC1c and fed to the inhibit of IC6. This amplitude modulates its output which is fed to the base of TR1 via a 27k ohm



resistor and a parallel ceramic capacitor. TR1 is a UHF transistor with a very high ft. In its collector is a 1N914 diode, a non-linear load, which generates harmonics. Finally the RF output is taken via 10pF ceramic capacitor, C3, to both a BNC connector and a terminal post, thereby offering a choice of connection.

Construction

The calibrator was constructed on

double-sided, copper clad glass fibre epoxy board, size 100mm x 60mm. The top surface of the PCB was used as a ground plane and the underside for interconnections. The artwork for the PCB and the component layout are given in figures 3 and 4. If you drill the PCB, copper surrounding the holes on the component side should be removed by countersinking with a 3/16 inch drill. The author used IC sockets throughout, but there is no reason why the IC's could not be soldered directly on to the PCB provided a low leakage soldering iron is used and normal CMOS precautions are observed. The two capacitors, C2 and C3 must be low inductance type, such as disc ceramic, so as to obtain a good high frequency response from the calibrator. Although IC1 is specified as a quad NOR gate, it is used throughout as an inverter - one input of each of the three gates used being grounded.

The crystal calibrator described is possibly more comprehensive than will be required in some instances. Various functions can easily be removed from the circuit if required. For example, if IC5 is omitted then the 12.5kHz option will be unavailable. If IC4 is omitted and pin-12 of its socket is connected to Vdd via 100K ohm resistor, then the tone facility will be unavailable.

Alignment

The calibrator is best aligned when it has been installed in its working position (box or rig). The station RX is switched to AM and tuned to one of the standard frequency services, such as MSF on 5MHz. The calibrator is switched on and loosely connected to the RX antenna socket in parallel with the antenna used to receive MSF. If the RX uses "UHF" type connectors, unscrew the outer skirt and pull the plug half way out of the socket. Take a length of wire, strip both ends, connect one end to the terminal post and loop the

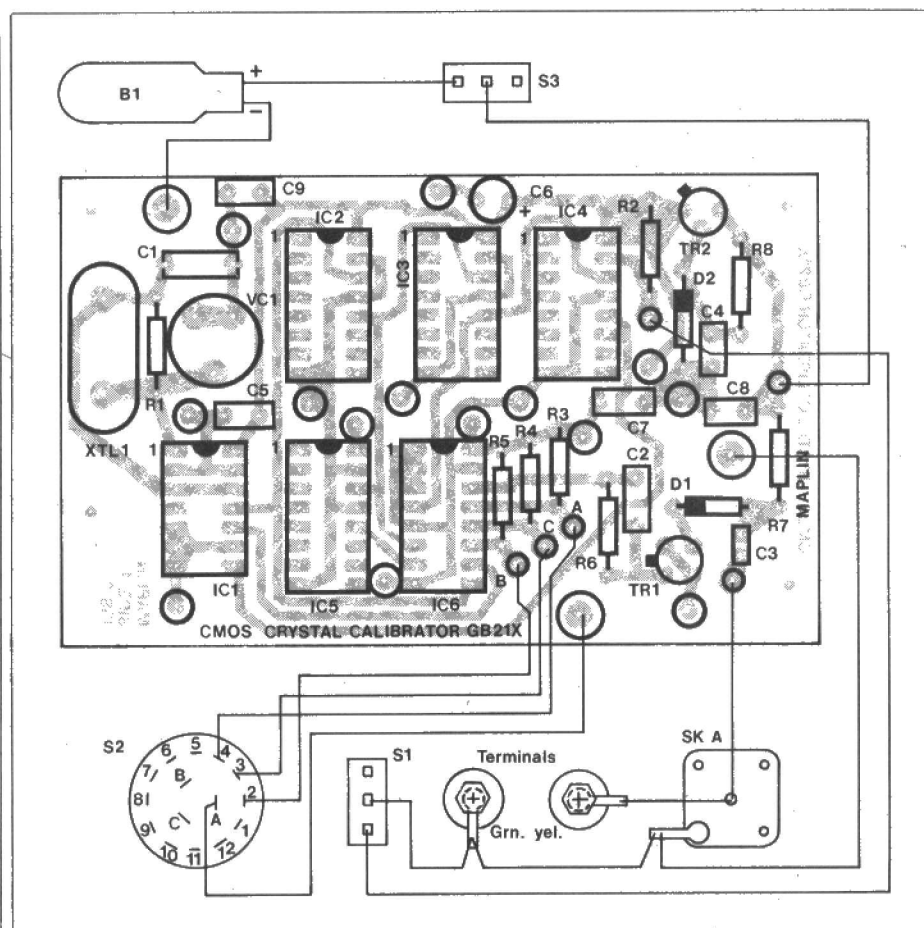


Figure 3. PCB layout and wiring diagram.

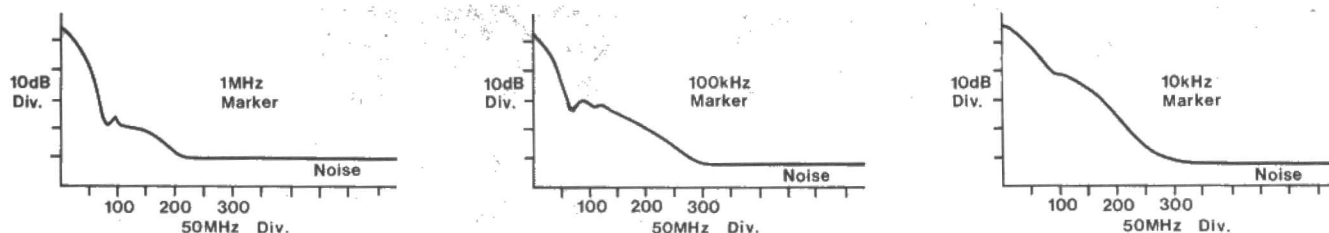
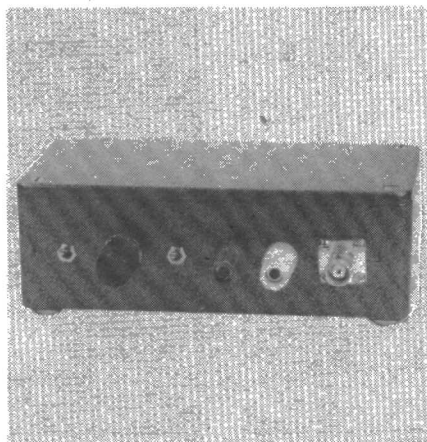


Figure 5. Test Graph.

other end over the exposed inner section of the plug. A beat note generated by the mixing of the standard service and the calibrator should be heard from the RX. To align the calibrator, trimmer capacitor VC1 should be adjusted to zero beat the two signals. An oscilloscope connected to the AF output from the RX is useful for monitoring the beat note frequency down to a few Hz. Zero beat is the position at which the beat note disappears after the note becomes progressively lower in frequency. Very low frequency beats, less than 1Hz, manifest themselves as a cyclic slow rise and fall in background noise level. The higher the frequency of the standard service used, the sharper, and hence more precise, will be the zero beat position. Note that an error of 10Hz at 5MHz will multiply to an error of 1kHz at 500MHz.

Applications

A crystal calibrator is used to check the calibration of receivers, and in the amateur sphere is particularly useful in checking the position of the edges of the amateur band allocations. To do this, the RX is tuned as close as possible to the required band edge. The calibrator is then loosely connected to the antenna socket of the RX. If the band edge is on a 1MHz boundary (28.0MHz) then 1MHz markers should be selected. Alternatively if the band edge is on a 100kHz boundary (3.5MHz-3.8MHz)



then select 100kHz. Failing this, 12.5kHz and 10kHz intervals are available for use. Receivers are usually calibrated according to the type of emission to be received.

For AM tune the RX for a peak S-Meter reading from the calibrator signal. If no S-Meter is available switch on the tone facility and tune for loudest tone. Using the tone facility, however, is of limited value as markers at 1kHz intervals tend to be generated but are lower in amplitude than the 100kHz and 1MHz signals. For SSB reception the RX should be set to receive the appropriate side-band and tuned so as to zero beat the calibrator signal. For CW, the situation is a little more difficult, as the RX is usually tuned about 800Hz lower in frequency than the incoming signal - this produces the

audible tone. Usually, however, receivers are calibrated such that SSB and CW give identical readouts, and therefore the RX should be set to receive CW and then tuned to zero beat the calibrator signal. It may not be possible to hear low frequency beat notes when using narrow CW filters. Note that a station transmitting on the same frequency as the calibrator would be inaudible, being zero beat, and the RX would normally be tuned about 800Hz away from the zero beat position in order to copy CW transmissions. It is important to remember that if the TX carrier is positioned close to a band edge care must be taken to ensure that no sidebands are radiated outside the authorised frequency band.

Acknowledgements

The author wishes to thank G3GIH, G3VMW, G3XAG and GW4JJV for their comments and suggestions during the course of this project.

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PARTS LIST FOR CRYSTAL CALIBRATOR

Resistors - All 0.4W 1% metal film unless specified

R1	1M0		(M1M0)
R2-5	100k	4 off	(M100K)
R6	27k		(M27K)
R7,8	10k	2 off	(M10K)

Capacitors

C1	22pF Mica		(WX05F)
C2,4,5,7-9	10nF Disc	6 off	(BX00A)
C3	10pF Ceramic		(WX44X)
C6	100uF PC elect.		(FF11M)
VC1	65pF Trimmer		(WL72P)

Semiconductors

D1	IN914		(QL71N)
ZD1	BZY88C8V2		(QH12N)
TR1	BF173		(QY53H)
TR2	EC108		(QB32K)
IC1	4001BE		(QX01B)
IC2-4	4017BE	3 off	(QX09K)
IC5	4022BE		(QW19V)
IC6	4512BE		(QW84F)

Miscellaneous

S1,3	SPST ultra min. toggle	2 off	(FH97F)
S2	Rotary SW4B		(FF75S)
SKA	BNC square skt.		(YW00A)
	Terminal post green		(HF05F)
	Terminal post yellow		(HF09K)
	DIL socket 14 pin		(BL18U)
	DIL socket 16 pin	5 off	(BL19V)
	PP3 Clip		(HF28F)
	PP3 Battery		
	1MHz FS crystal		(HX62S)
	Crystal Socket 6u		(HX61R)
	PC Board		(GB21X)
	Box DCM5005		(LH73Q)
	Collet knob black		(RX16S)
	15mm collet cap black		(WL45V)
	15mm collet nut cover		(RX18U)
	Stick-on feet	1 pkt	(FW38R)
	Bolt 6BA 1/2in	1 pkt	(BF06G)
	Washer 6BA	1 pkt	(BF22Y)
	Shake 6BA	1 pkt	(BF26D)
	Nut 6BA	1 pkt	(BF18U)
	Tag 6BA	1 pkt	(BF29G)
	Wire black	1 metre	(BL00A)
	Veropins type 2141	1 pkt	(FL21X)
	Track pins	1 pkt	(FL82D)

A complete kit of all parts, excluding the case, is available.
Order As LK10L (X'tal Calibrator Kit). Price £15.95

WORKING WITH OP-AMPS

(Part six) by Graham Dixey C.Eng., M.I.E.R.E.

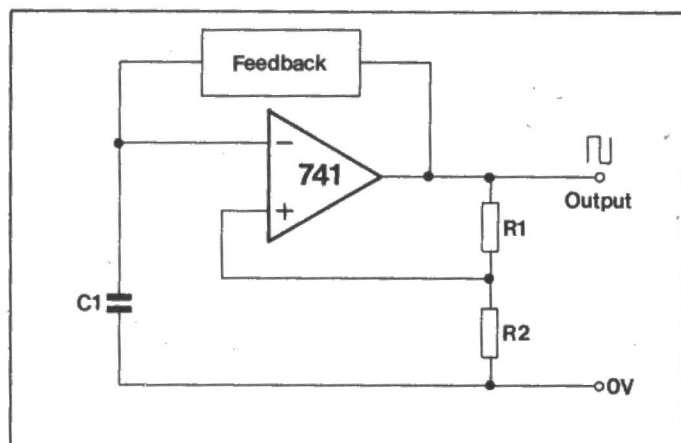


Figure 1. Basic astable waveform generator.

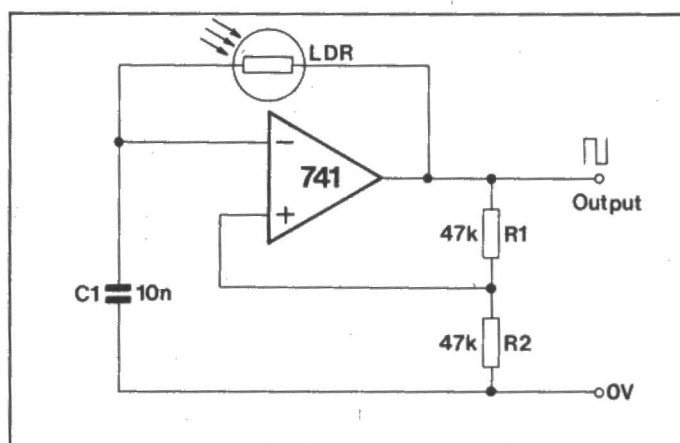


Figure 2. A 'light-to-sound' converter.

This, the final part in this series, deals with circuits that, in one way or another are concerned with sound - either its generation or control. In previous parts, the role of the op-amp, as a linear amplifier, as a waveform generator and as an active filter have been discussed. Applications of these ideas in practical situations will now be shown. A 'generator of sound' circuit implies ultimate connection to a loudspeaker and, hence, the need for some form of power amplifier. The exact nature of such an output stage depends upon the nature of the application - consequently such details are left to the individual experimenter. The exception to this is the 'frost alarm' which, being intended for automobile use, includes a 12V output stage suitable for this specific application.

Sound Generators and Alarms

Figure 1 shows the basic square-wave generator, first introduced in Part 2 of this series as the 'astable multivibrator'. The non-inverting input is 'tied' to a fixed potential by R1/R2 and the circuit changes state every time that C1 charges to a value just in excess of this value. The rate at which the

charging occurs is determined by the values of C1 and the feedback component. This latter is often a resistor in the basic astable circuit but it may be replaced by an alternative component to give more interesting results.

In Figure 2 the feedback component is a photocell or L.D.R. (Light Dependent Resistor). This has the property that, 'in the dark', its resistance is extremely high but falls dramatically when illuminated. The actual resistance in the extreme cases depends upon the photocell type. Some idea of values can be gained from the characteristics of Figure 3 for a typical small photocell. If the resistance of the cell is high enough, the frequency will be too low to be audible. For example, if $C = 100\text{nF}$ and the cell resistance is $1\text{M}\Omega$, then the frequency will be a mere 4.55Hz , well below audibility. But, when the cell resistance falls to $10\text{k}\Omega$, the frequency is 455Hz .

This leads to the idea of using the circuit as the basis of an 'alarm system', using the word alarm in the broadest sense of the word, to mean an audible indication of some event having occurred. Thus, in general, the presence or absence of light may be indicated; such a circuit may be called a 'light-to-sound' converter.

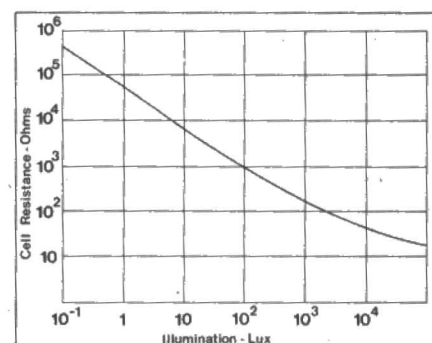


Figure 3. Characteristic of typical small photoconductive cell (LDR).

As an alternative to the photocell, a thermistor could be used. In this device a change of temperature causes a change of resistance, either an increase - positive temperature coefficient (p.t.c.) or a decrease - negative temperature coefficient (n.t.c.). Figure 4 shows a thermistor used as the feedback component in a circuit that could now be described as a 'heat-to-sound' converter. Normal temperature variations may not produce such dramatic shifts of frequency as the light-to-sound converter, but they are nonetheless significant.

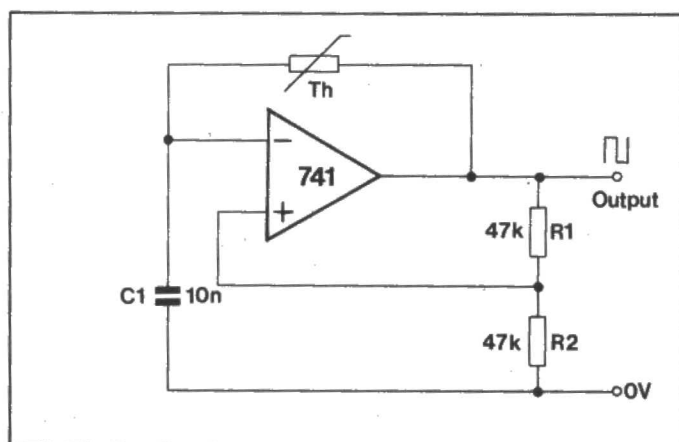


Figure 4. A 'heat-to-sound' converter.

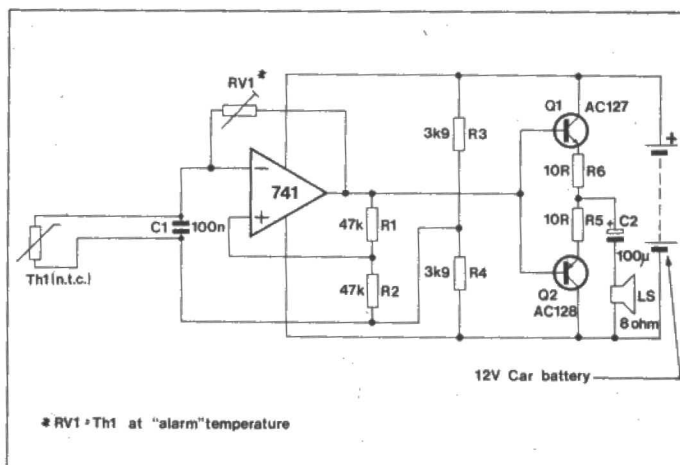


Figure 5. A 'frost alarm' for a car.

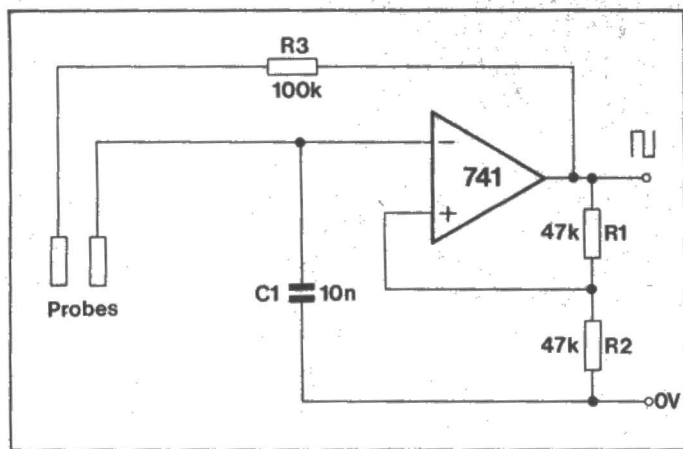


Figure 6. Circuit to detect presence of water.

Still on the subject of sensing temperature changes, Figure 5 shows a variation on the theme put to practical use in a car. The circuit is of a 'frost alarm', intended to warn the driver by an audible signal of the imminence of freezing conditions. The sensor is an n.t.c. thermistor mounted low down at the front of the vehicle. However, this time the thermistor is wired in parallel with the capacitor C1 and the feedback path is a preset potentiometer RV1. The idea behind this arrangement is that if the value of Th's resistance is less than that of RV1 (such as will apply above freezing point), then the charge on C1 leaks away too quickly for the switch-on point to be reached; result - no oscillations, no audible output. But at freezing point the thermistor resistance has increased enough to allow oscillations to take place, giving an audible warning. RV1 is adjusted to set the precise point at which the circuit bursts into oscillation. Try the domestic ice-box as a means of testing it! Because it is intended for automobile use, the power supply is organised to use the car's 12V battery and a simple complementary-symmetry output stage is included. Alternatively, an IC power amplifier could be used.

Figure 6 shows a very simple on/off alarm to detect the presence of water or some other conducting liquid between the 'probes'. These are closely spaced so as to be easily bridged by the moisture droplets; two adjacent tracks on a P.C.B. would serve. The liquid closes the otherwise open feedback path and the circuit oscillates. Possible applications include its use as a rain alarm or as a sensor of liquid level in some container.

Figure 7 likewise is extremely simple. Operation of any of the push-button

switches, S1-S3 (or as many others as you like) causes the circuit to oscillate, each switch having its own unique frequency because of the resistor value that it selects. Thus, in a door-calling system, each door is identified by its own distinctive tone. Details of tone frequencies appear on the figure.

These are just a few of the ways in which the op-amp astable circuit can be put to good use. As a change from this 'switching' mode, consider now two examples of its use as a linear device in the field of audio.

The first of these is shown in Figure 8 and is an automatic level control circuit as used, for example, in a tape recorder. It is used in conjunction with a field effect transistor, the well-known 2N3819. This FET is employed as a 'voltage variable resistor', making use of the pre-pinch-off region of the drain characteristics. Together with R4, a 330k Ω resistor, it forms a potential divider across the output of the op-amp. The proportion of output voltage developed across the drain-source path is fed back through R2 to control the gain of the op-amp. Thus, op-amp gain is controlled by the value of the FET's drain-source resistance. This, in turn, is controlled by the bias on the gate of the FET, and this is derived from the output signal itself by a simple rectifier circuit (D1; R5; R6; C1). Thus, the level of the output signal controls the op-amp gain which, in turn, controls the output level - a closed loop of dependence. All being well, the output maintains itself fairly constant over a wide range of input signal amplitude. For a small input signal, the op-amp gain rises in an attempt to hold the output constant. With a large input signal, the op-amp gain is turned down, giving the same result.

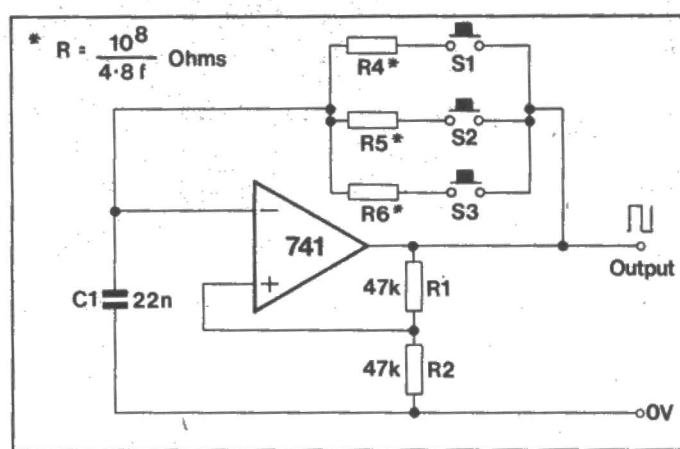


Figure 7. A door calling system.

Finally, Figure 9 shows an op-amp used to give equalisation to the signals from a magnetic pick-up for disc reproduction. These magnetic pick-ups produce an output voltage which depends upon stylus velocity; since the latter rises with signal frequency, so does the output voltage. What is required, of course, is a level response at all audio frequencies, the only 'tailoring' of the response being carried out by the tone controls.

This level response is achieved by using a pre-amplifier with a falling response that more or less balances the rising response of the pick-up. This is called 'equalisation' and produces the R.I.A.A. characteristic, also shown in Figure 10. (R.I.A.A. = Radio Industry Association of America). The feedback components shown as parallel pairs together with the gain of the op-amp produce an active filter with the required characteristic. Resistor R1 presents the required load to the magnetic pick-up.

This series has explored a variety of circuits involving op-amps. Even so, it has only scratched the surface of the possibilities. Nonetheless, it is hoped that it has been both instructive and inspirational to all those who now find themselves 'working with op-amps.'

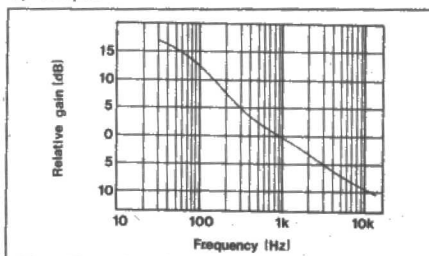


Figure 10. The RIAA equalised disc playback curve.

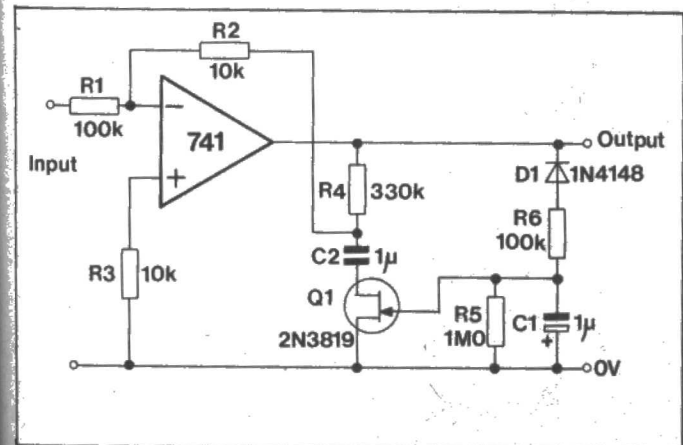


Figure 8. Automatic sound level circuit.
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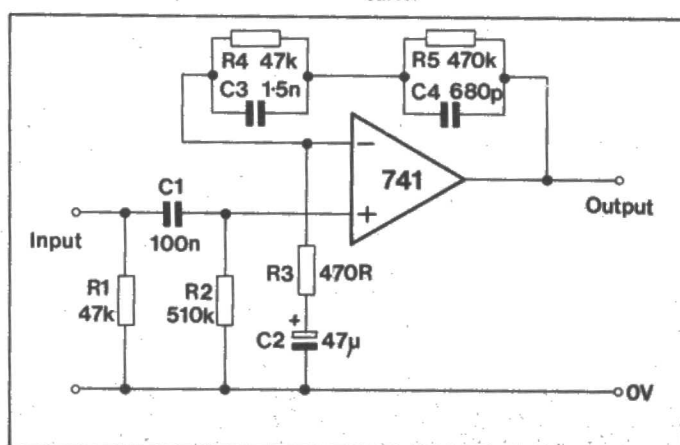


Figure 9. RIAA equalised pre-amplifier for disc reproduction.

DXER'S AUDIO PROCESSOR

- ★ Improved performance
- ★ Needs no modifications to receiver
- ★ High filter attenuation rate
- ★ Easy to build



by Robert Penfold

The performance of many communications receivers is not all that one would desire, and probably the most common failing is a lack of really good I.F. filtering which results in an excessive amount of adjacent channel interference. A simple way of obtaining improved performance is to use an audio filter to process the audio output of the receiver, and although this does not give a level of improvement equal to that produced by adding high quality I.F. filters to the receiver, it nevertheless gives a substantial improvement. An advantage of this system is that it avoids the need for any modifications to the receiver (which, even if successful, could reduce its resale value), and the filter is simply wired between an audio output socket of the receiver and the headphones or a loudspeaker.

This filter has a 36dB per octave lowpass filter with a cutoff frequency of about 2.5kHz, and an 18dB per octave highpass filter with a cutoff frequency at about 150Hz. This very restricted audio bandwidth helps to greatly attenuate adjacent channel interference but does not impair the intelligibility of speech signals. The high attenuation rate of the filters, particularly the low-pass type, gives the unit a level of performance which is superior to most audio processors of this type.

An additional and useful feature of this audio processor is an expander. In the presence of a reasonably strong signal this allows the signal to pass through to the output normally, but when the signal level is low (during pauses in a voice signal for example) the signal is severely attenuated. By reducing the noise during gaps in the wanted signal it is often easier to copy

the signal, especially where it is necessary to copy the signal for some time. Under some circumstances the use of the expander can produce an apparent boost in the signal to noise ratio of the processed signal, and it can make a worthwhile reduction in general background noise as well as adjacent channel interference.

Just how well or otherwise the unit performs depends almost entirely on the receiver with which it is used and on reception conditions. There is obviously more scope for the processor to produce an improvement if it is used with a wide bandwidth receiver under poor conditions than if it is used with one that has good I.F. filtering and under good reception conditions. However, the prototype has been tried over a period of a few months with a short wave receiver which has 7kHz mechanical I.F. filters, and a comparison of

the processed and unprocessed signals almost invariably revealed a substantial improvement with the processor in use, especially for S.S.B. reception. The unit has also been tried with an F.M. C.B. transceiver with similar results.

Block Diagram

Figure 1 shows the block diagram for the processor, and as will be apparent from this, the filtering is used before the expander stages. This is important as it helps to prevent unwanted signals from operating the expander, and it does so simply because the filtering prevents some of these unwanted signals from reaching the expander. A buffer stage is used at the input to ensure that the lowpass filter is fed from a suitably low source impedance, and the lowpass filter is actually two 18dB per octave filters in series rather than a single filter block.

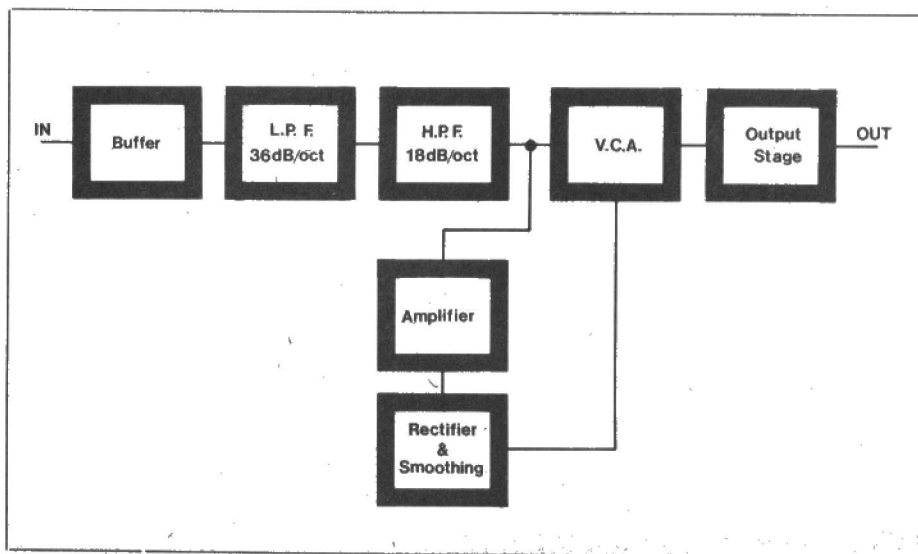


Figure 1. Block diagram.

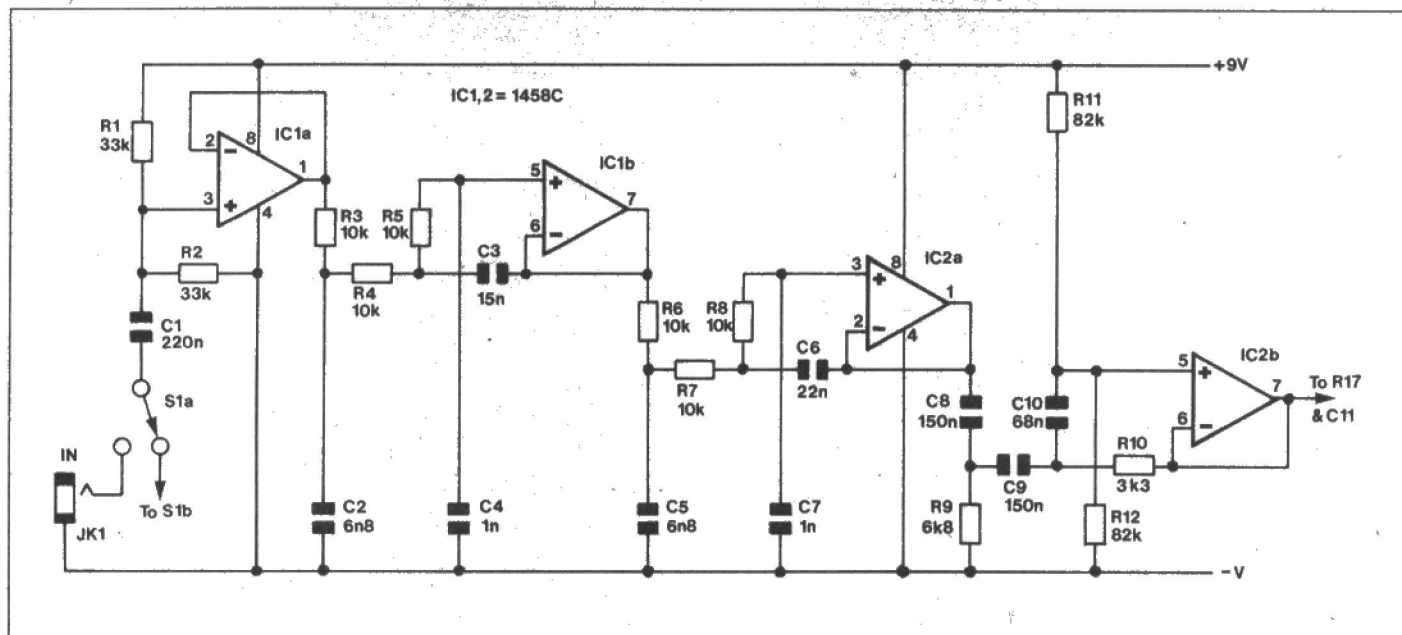


Figure 2. Circuit diagram of the filters.

After passing through the highpass filter the signal is fed through a voltage controlled amplifier (V.C.A.) which has only a small control voltage under quiescent conditions. It consequently attenuates the input signal. Some of the output of the highpass filter is fed to an amplifier, and then the amplified signal is rectified and smoothed to produce a D.C. signal which is roughly proportional to the amplitude of the input signal. This D.C. signal is fed to the control input of the V.C.A. and provides an increase in gain if the input signal is sufficiently strong. Thus the required action is obtained with low level signals being attenuated while high levels signals are through the V.C.A. unattenuated.

The output stage will drive any normal type of headphones, and will also drive an 8 ohm impedance loudspeaker with an output power of up to about 500mW R.M.S.

The Circuit

Figure 2 shows the circuit diagram for the input buffer and filter stages of the unit. IC1a is the buffer stage and is a straightforward non-inverting unity voltage gain circuit which is biased by R1 and R2.

IC1b is used as the basis of the first section of the lowpass filter, and this uses a standard configuration. R3, R4, R5, C3 and C4 effectively form a second order active filter, but due to the high value of C3 a pronounced peak in the response is produced just below the cutoff frequency. R3 and C2 form a passive low pass filter which removes this peak and gives an excellent overall response with an abrupt introduction of the full 18dB per octave attenuation rate. The second lowpass filter stage is based on IC2a and is virtually identical to the first stage. The only difference is that C6 has a slightly higher value than its equivalent in the first filter section (C3), and this gives a slight improvement to the combined responses of the two filters.

The highpass filter uses IC2b, and the configuration used is essentially the same as that employed in each section of the lowpass circuit, but the resistive and capacitive filter elements are transposed to give a highpass and not a lowpass action. The final resistive element of the filter is formed by the parallel resistance of R11 and R12, and as there is no D.C. path through C8 to C10 to bias the non-inverting input of IC2b these are used to provide a suitable bias voltage.

Figure 3 shows the combined frequency response of all three filter sections.

Expander

The circuit diagram of the expander and output stages of the processor are shown in Figure 4. The V.C.A. is built

around IC3 which is an operational transconductance amplifier and IC4 which is merely used as a buffer amplifier. R17 and R19 form a negative feedback network which set the voltage gain of the V.C.A. at unity, but this assumes that the bias current fed to the amplifier bias input of IC3 (pin 5) is sufficient to produce unity voltage gain. With RV1 at minimum resistance this will indeed be the case and the expander action of the circuit is eliminated. However, with RV1 at maximum value the quiescent bias current is greatly reduced and there is a substantial amount of attenuation through the V.C.A. Intermediate settings of RV1 give a corresponding degree of attenuation through the V.C.A.

Some of the output from the final filter stage is taken via sensitivity con-

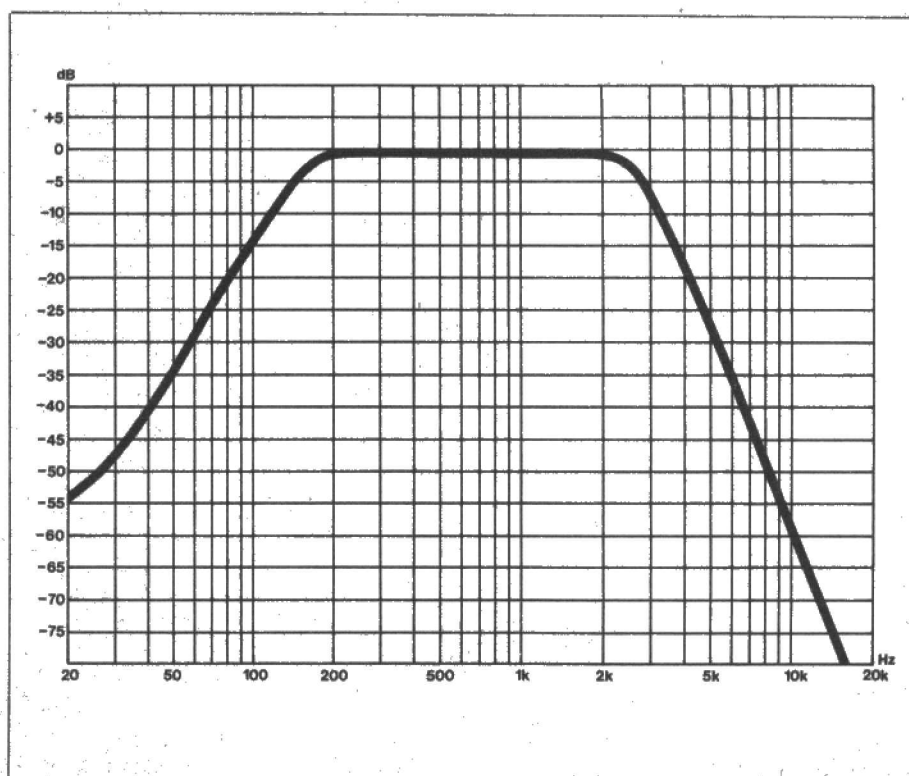


Figure 3. Frequency response of the unit.

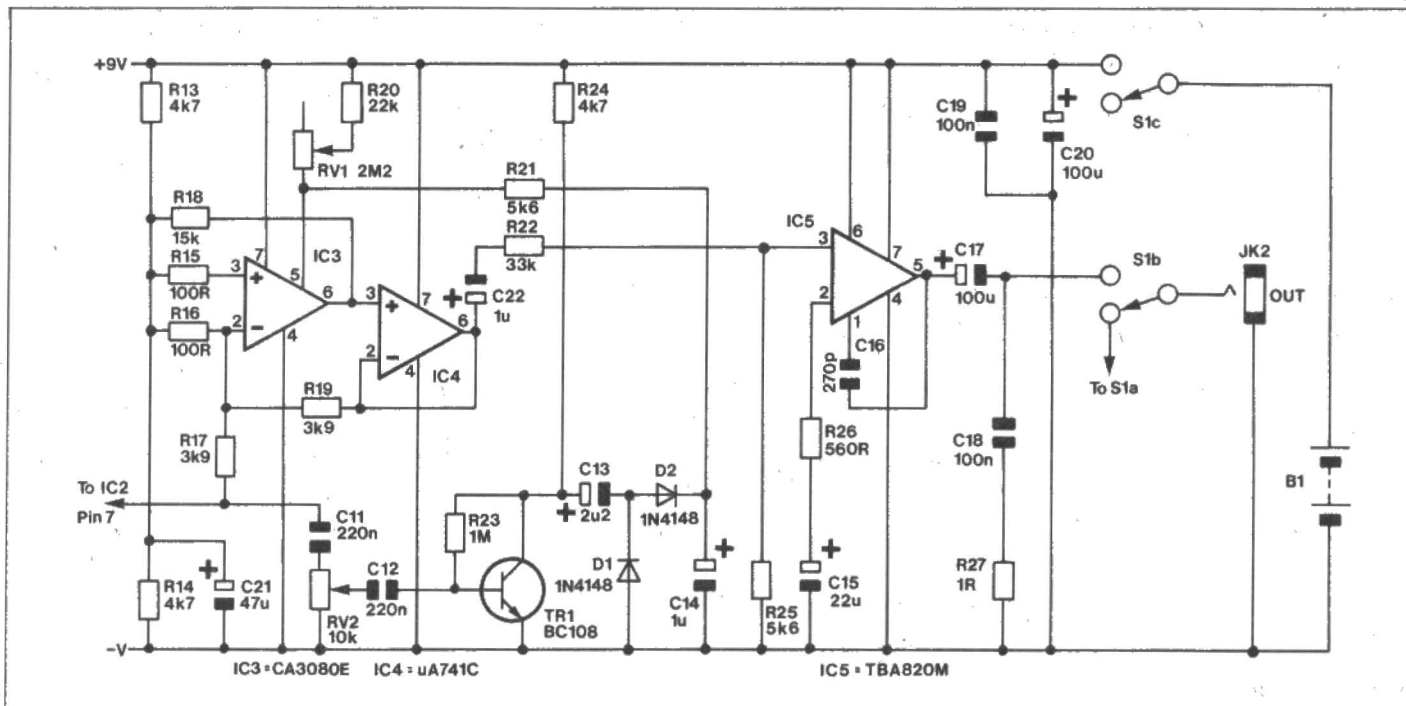


Figure 4. Circuit of the expander and output stages.

trol RV1 to a high gain common emitter amplifier which uses TR1. The output of TR1 is rectified by D1 and D2, and smoothed by C14. The resultant positive voltage is fed to the V.C.A. by way of R21, and in the presence of a strong input signal boosts the gain of the V.C.A. to unity regardless of the setting of RV1. RV2 is adjusted so that the wanted signal operates the expander circuit but the background noise does not. In practice the circuit tends to operate for the majority of the time at full gain or the lower gain level set using RV1, and it therefore operates virtually as a noise gate. However, as the V.C.A. is not switched between two levels of gain and it can have intermediate levels of gain, strictly speaking the circuit is an expander and not a noise gate. The attack and decay times of the circuit are quite short so that the unit responds to changes in input level with adequate rapidity.

A TBA820M integrated circuit is used in the output stage and this device gives an output power which is more than sufficient for this application. R26 is a discrete feedback resistor which sets the closed loop voltage gain of the amplifier at a modest level of just over 20dB, but this is still excessive for this application. An attenuator consisting of R22 and R25 is therefore used to reduce the gain of the circuit to a satisfactory level.

S1 is a bypass switch which can be used to cut out the processor when it is not required, and one pole of S1 (S1c) is used to provide on/off switching. Power is obtained from a PP6 size 9 volt battery and the quiescent current consumption of the circuit is approximately 8.5mA. The current drain increases substantially, though, if the unit is used at high volume with an 8 ohm impedance loudspeaker, and if used in this way it would be advisable to use a larger battery, such as a PP9 size.

PARTS LIST FOR DXer's AUDIO PROCESSOR

Resistors — all 0.4W 1% metal film unless specified.

R1,2,22	33k	3 off	(M33K)
R3,R8	10k	6 off	(M10K)
R9	6k8		(M6K8)
R10	3k3		(M3K3)
R11,12	82k	2 off	(M82K)
R13,14,24	4k7	3 off	(M4K7)
R15,16	100R	2 off	(M100R)
R17,19	3k9	2 off	(M3K9)
R18	15k		(M15K)
R20	22k		(M22K)
R21,25	5k6	2 off	(M5K6)
R23	1M		(M1M0)
R26	560R		(M560R)
R27	1R (1/4W 5% carbon)		(B1R0)
RV1	2M2 lin pot		(FW09K)
RV2	10k lin pot		(FW02C)

Capacitors

C1,11,12	220nF carbonate	3 off	(WW45Y)
C2,5	6n8 polycarb	2 off	(WW27E)
C3	15nF polyester		(BX71N)
C4,7	1nF mylar	2 off	(WW15R)
C6	22nF polyester		(BX72P)
C8,9	150nF polyester	2 off	(BX77J)
C10	68nF polyester		(BX75S)
C13	2u2 63V elect		(FB15R)
C14,22	1uF 63V elect	2 off	(FB12N)
C15	22uF 25V elect		(FB30H)
C16	270pF ceramic plate		(WX61R)
C17,20	100uF 10V elect	2 off	(FB48C)
C18,19	100nF polyester	2 off	(BX76H)
C21	47uF 10V elect		(FB38R)

Semiconductors

IC1,2	1458C	2 off	(QH46A)
IC3	CA3080E		(YH58N)
IC4	741C 8 pin DIL		(QL22Y)
IC5	TBA820M		(WQ63T)
TR1	BC108		(QB32K)
D1,2	1N4148	2 off	(QL80B)

Miscellaneous

S1	4 way 3 pole rotary		(FF76H)
JK1,2	Standard 1/4 in. jack	2 off	(HF90X)
B1	9V PP6 size		
	Case		(XY45Y)
	Battery connector		(HF28F)
	Control knobs	3 off	(HB26D)
	Printed circuit board		(GB19V)
	6BA 1/4 in. bolts	1 pkt	(BF06G)
	6BA nuts	1 pkt	(BF18U)
	6BA 1/4 in. spacers	1 pkt	(FW34M)
	Veropins type 2145	1 pkt	(FL24B)
	Wire	(as req.)	(BL00A)

A complete kit of all parts, excluding the case and knobs, is available.
Order As LK05F (D'Xers Audio Processor kit). Price £14.95.

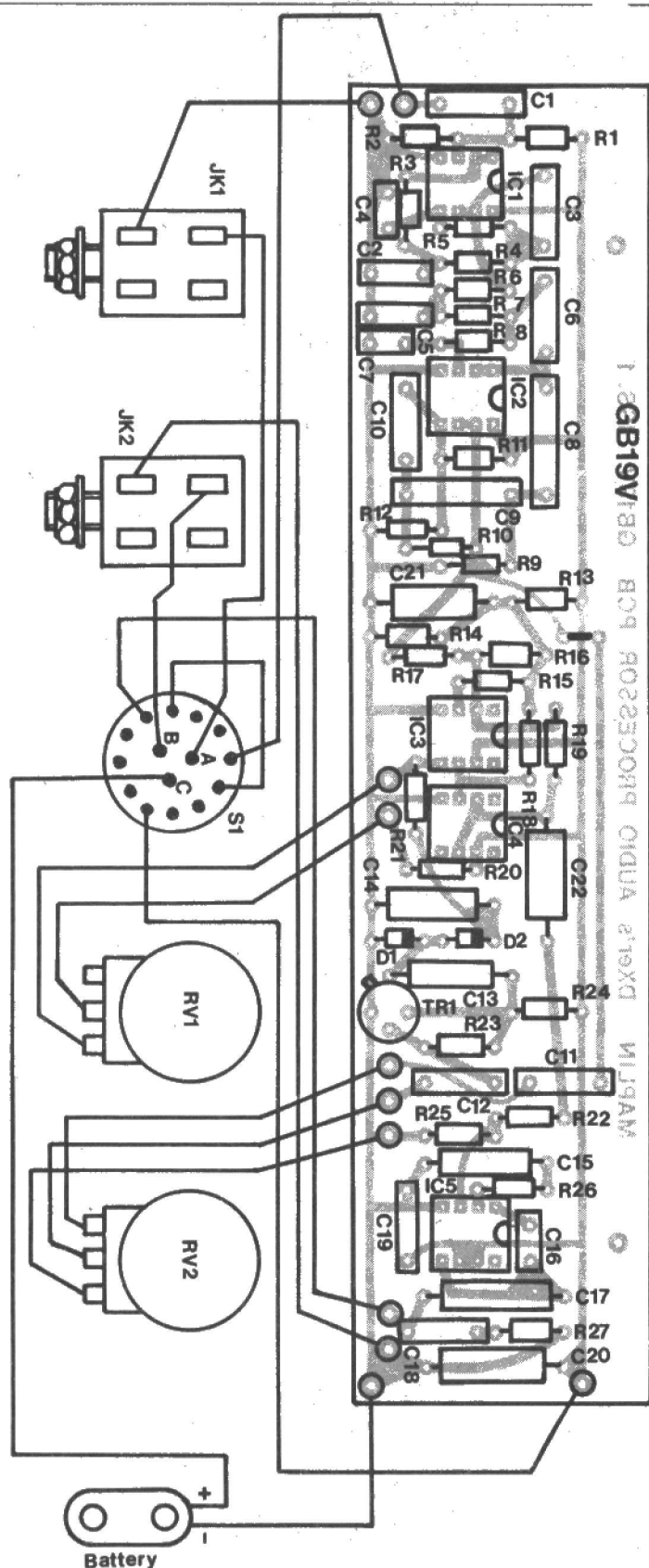


Figure 5. PCB layout and wiring.

Construction

Refer to Figure 5 for details of the printed circuit board and wiring of the unit. Veropins are used at points on the printed circuit board where connections to off-board components will be made. Be careful to fit the semiconductor devices onto the board with the correct orientation, especially the integrated circuits which would be difficult

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to remove from the board once soldered into place. Note that there is a single link wire on the board (near to R13 and R16).

An instrument case having approximate outside dimensions of 200 by 125 by 75mm makes a good housing for this project, and a suitable front panel layout can be seen by referring to the photographs. S1 is a 4 way 3 pole rotary type having an adjustable end stop, and the latter is set for 2 way operation. The

recommended case has an aluminium chassis and the completed printed circuit board is mounted on this using 1/2 inch 6BA bolts plus 1/4 inch 6BA spacers to hold the underside of the board well clear of the chassis. Mount the board towards the front of the chassis so that there is sufficient space for the battery to the rear of the board. The unit is then finished by wiring in the controls, battery connector, and sockets.

continued on page 62

FIRST BASE



by Mike Wharton

A Beginner's Guide to Logic Design Part Two

Introduction

You should by now have built, or have access to, a DC supply providing a regulated 5 volts. This will be used as the power supply for the various experiments which will mainly use Transistor-Transistor Logic devices, or TTL for short. If such a supply is not available it is possible to use batteries at a pinch, although the commonly available voltages are either just too high or too low. For example, a 4.5V battery may be used with no risk of damaging any chips, but as its output voltage falls with use, it may become insufficient to operate some of the devices properly. This can lead to some very misleading problems for the unwary. A 6V dry battery, on the other hand, is really too high, although with care it can be reduced with a suitable series resistor. Possibly the best source in this line would be four 1.2V NiCad cells connected in series; this gives 4.8V which will remain fairly constant during discharge. These cells may, of course, be recharged — which brings us back to a mains power supply again!

Chips with everything

A feature of modern electronic apparatus is that often somewhere lurking inside the most mundane item will be found at least one 'chip'. A glance through any electronics component catalogue will reveal that there must by now be umpteen thousands of different types, shapes and sizes. The electronic 'chip' is distinguished from the potato variety by being packaged in a rectangular black (usually), box from which protrude two rows (usually) of sharp metal pins or legs. Its type will be indicated by a code number printed on the top side, and pin number '1' identified in one of several ways, as shown in Figure 1.

All the wide variety of chips produced by modern technology may be divided into two categories, Analogue and Digital. We shall only be concerned at this stage with the digital variety; the analogue types (or analog, if you speak American) consist of all manner of specialist devices intended for particular applications.

Before we start any cookery with these chips it is essential that we all know and can identify the devices which are going to be

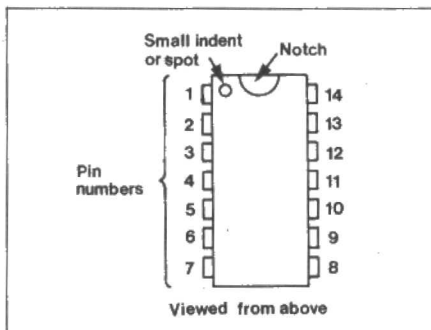


Figure 1. 14-pin dual-in-line (DIL) package.

needed; there are several 'grades' of TTL device, and the one of interest to us is the 7400 series. Each device in this series has a specific part number, starting with the two figures '74'. Thus the first in the series, 7400, is listed as a quad two-input NAND gate, which at first glance may seem to be a bit of a mouthful. What this means will be clear later, but first there are some more numbers which you will find on the package which need to be explained to avoid confusion. Figure 2 shows a typical chip of this type; in this case the part number is pre-fixed by the letters SN, which originally stood for Semiconductor Network, and is still used by some manufacturers. Other manufacturers may use other letters, such as DM, whilst some use none at all. Finally, the type number may end with a single letter, the commonest being 'N', which indicates a plastic package.

Very often the chip will have another number stamped close to the type number, and may look similar to the type number. This is a date stamp, which indicates the week and year of manufacture. For example, the number 7933 would mean that the chip was made during week 33 of 1979; some confusion may arise if you come across old

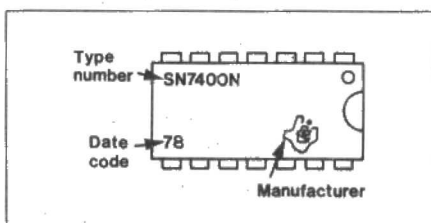


Figure 2. Typical markings on TTL packages.

chips made during 1974, so beware if you buy some 'bargain packs' of suspect devices.

Schottky Devices

Before moving off the subject of chip identification, it may be useful to say a few words about some of the more modern TTL devices. One of the few drawbacks to using TTL devices is that they use a relatively large amount of current, and this can be a problem if designing commercial equipment which uses many such devices. An improvement which has led to a reduction in current consumption without seriously affecting some of the other properties of these devices has produced a range of chips commonly called Low power Schottky, or 'LS' for short. Generally, these are made as pin-for-pin replacements for the standard types, and with a few exceptions may be used instead. The method of identifying this type of device is to insert the letters LS after the '74' of the type number; for example, a 74LS00 would be the Low power Schottky version of the standard 7400 device. Indeed, there are other letters which you may have noticed in this sort of type number, indicating yet further variations, but we'll cross that bridge when we come to it.

Logic Levels

Since we are dealing with digital devices, it is important at the start to make certain that what this entails is properly understood. The segregation of chips into analogue and digital varieties was mentioned above, and it is true to say that one deals with analogue quantities and the other with digital quantities. An analogue quantity is one which is continuously variable, and although this may be a voltage it could equally well be the amount of liquid flowing down a pipe, the speed of the wind or the intensity of light from the sun. All of these quantities can be converted into a proportional voltage by suitable means. A digital quantity, on the other hand, is one which changes by fixed amounts, with no fractional parts in between. Thus the number of people in a group is a digital amount, you cannot sensibly have three-and-two-thirds people. Likewise, in digital electronics, we are concerned with voltage signals which have just two levels, and ideally nothing in between. Using TTL

devices these levels are +5 volts and 0 volts, with the +5 volt level being assigned the logic value of '1' and 0 volts a logic value of '0'. Again, there are other systems, but we shall not concern ourselves with them.

The great advantage of this system is that it actually makes the representation of numbers a lot easier than any analogue system; for instance, suppose you wanted to show a value of '5' using a range of voltages between 0V and 10V. Easy, you say, that would be given by 5 volts, but now imagine you need to show a value of 255 on the same voltage range. One solution would be to make the 10V equal to a value of 1000, so that 255 would be given by a voltage of 2.55 volts. This would then mean that only 0.01 volt represents a value of 1, and this is such a small voltage that any practical system would be hopelessly inaccurate. By adopting

VALUE	
+5Volts	0 Volts
Logic 1	Logic 0
True	False
Valid	Invalid
High	Low

Figure 3. The positive true logic notation system.

a digital system any value can be created with perfect accuracy. This is the basis of the modern digital computer, but more of that later, as we are getting ahead of ourselves. At this stage it is sufficient to appreciate that the presence of 5 volts, or a voltage very close to it, represents logic 1, and 0 volts, or again a value very close to that, is logic 0. These logic values do not necessarily stand for the numerical values of 1 and 0, but might equally well mean True and False, or Valid and Invalid in terms of logical arguments, and Figure 3 summarises these ideas.

Truth Tables

The introduction of the idea of logic brings us next to the subject of Truth Tables; these have been adapted from the subject of Boolean Algebra as a convenient method of describing the performance of a particular logic chip. Mention of such things as Boolean Algebra may have caused some of you to wonder what you might have let yourselves in for. If so, then rest assured that this series will stick to the practical path, and although it is difficult to ignore it completely, those readers wishing to delve more deeply into this fascinating subject will have to look elsewhere.

If you have studied the subject of electronics previously, then it is quite possible that you have come across the so-called characteristic curves for active devices such as transistors. These are used to describe in a graphical form how such things react when voltages are applied to them, and can be used to make sure that the transistor is operated under the correct conditions. Fortunately, as far as TTL chips are concerned, we can treat them as what they are — little black boxes! Although they may contain several hundred individual transistors, provided some simple rules are adhered to it is possible to ignore this when connecting together a number of different devices. This makes it possible to make up quite complex logic designs with the ability to predict the manner in which the final circuit will behave, something which would be extremely difficult using any other system with separate transistors.

Truth Table		
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

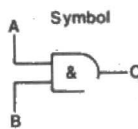


Figure 4. Two input AND gate.

Figure 4 shows the Truth Table for a two-input AND gate alongside the commonly used symbol for this gate in circuit diagrams. It may as well be said at this stage that although this is not a British Standard symbol, it is the one which is most likely to be found in published circuit diagrams, and there seems little point in swimming against the tide!

The explanation of the Truth Table given is quite straightforward; the two inputs to the logic device or 'gate' are labelled A and B, whilst the output is C. The Truth Table simply summarises the various outputs which would be obtained for all possible combinations of input. Thus, if both inputs are connected to logic 0, or 0 volts, then the output will be 0 volts. Only if both inputs are connected to logic 1, or +5 volts, will an output of logic 1 be obtained. This shows why the gate is called an AND gate, since both input A AND input B must be 'high' for the output to be 'high', all other combinations

Truth Table		
A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

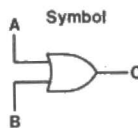


Figure 5. Two input OR gate.

Truth Table		
A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

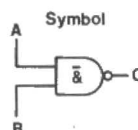


Figure 6. Two input NAND gate.

Truth Table		
A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

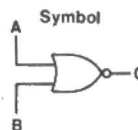


Figure 7. Two input NOR gate.

giving a 'low' output. Figures 5, 6 and 7 show the corresponding Truth Tables and symbol for three more common logic gates; figure 5 is for a two-input OR gate, figure 6 a two-input NAND gate and figure 7 a two-input NOR gate. The last two gates deserve a little more mention, as they are the opposites of the first two. That is, if you look at their Truth Tables, you will see that similar inputs produce opposite outputs, so that logically a NAND gate is a Not AND gate and a NOR gate is a Not OR gate.

Practical Devices

If you have a copy of the Maplin catalogue (if not, why not!) and turn to page 282, you will see the pin-outs of a number of TTL chips. You will also see that only rarely does a package contain a single device. For those without this valuable reference aid, the pin-out of a 7400 is given in figure 8. This is where we come back to that mouthful of a name used to describe such packages. Thus a 7400, which contains four identical two-input NAND gates, is listed as a Quad 2-input NAND gate, whilst the 7420 is a Dual 4-input NAND gate, ie two NAND gates each having four inputs.

Two other pins identified in figure 8 are labelled Vcc and GND; these are the pins to which the necessary power supply for the whole package is connected, with Vcc being connected to +5 volts and GND, or Ground, to 0 volts. Usually, Vcc is pin 14 and GND pin 7 on a 14-pin DIL package, but there are

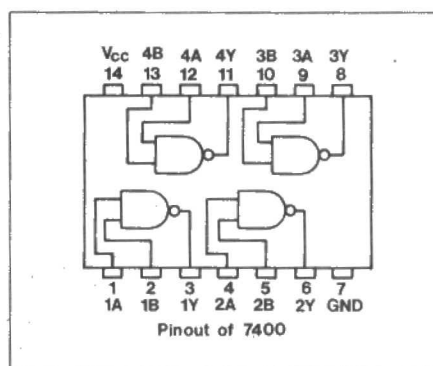


Figure 8. Quad two input NAND gate.

some important exceptions, and it is wise to check the pin-out when making up circuits. If you examine published diagrams these connections are often left out for the sake of clarity, but of course the circuit will not work without them!

Watch Your Combinations

The connecting together of various logic gates, such as NAND gates and NOR gates, to produce designs with predictable output states, is called Combinational Logic. To take a very simple example to start with; suppose that both inputs of a 2-input NAND gate are connected together, the Truth Table will

Truth Table	
A	B
0	1
1	0

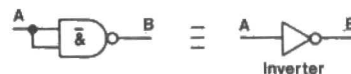
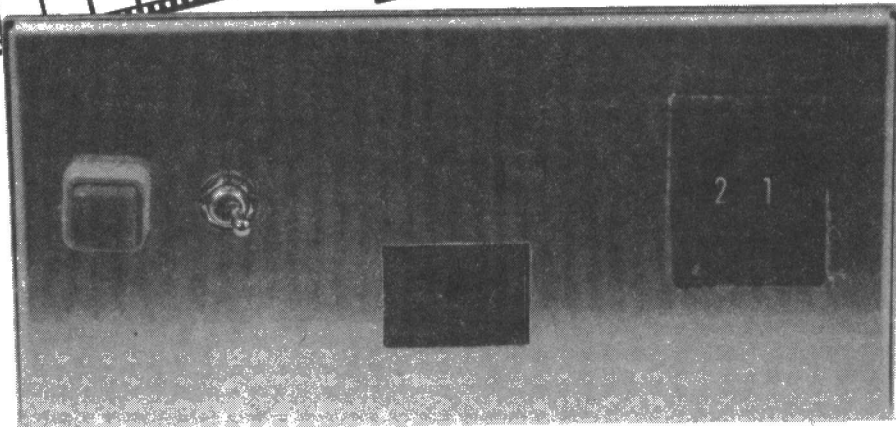


Figure 9. NAND to NOT conversion.

become as given in figure 9 as there is now effectively only one input. The result is a NOT gate, or inverter, since the output is the inverse of the input. This is also true for the NOR gate, and this is often a convenient way of producing an inverter from spare gates within a package.

It is true to say that the NAND gate is the most versatile of all those available, since the others can be made up by a suitable combination of NAND gates. For example, figure 10 shows how a 2-input NOR gate may be made up by this method. You can check out the Truth Table for this logic array by first giving the two inputs, A and B, the value 0. Then by following the Truth Table for the

DIGITAL ENLARGER TIMER/ CONTROLLER



by David J. Silvester

Reversal colour printing does not permit the use of a safelight, whilst the safelight for negative colour work is so dim as to make exposure timing with a clock almost impossible. The only enlarger timers for sale were of a mechanical type and it was felt that using CMOS logic a suitable timer could be made at a cost below that of the 'off the shelf' item.

Given that the timer must be operated by feel alone the controls were reduced to a thumbwheel 'time set' switch and two control switches. This introduces two possible methods of operation. The timer may either count the elapsed time up or down, and it was felt that the up counting system which allows the time display to show the exposure time before operation would prevent the author from making too many exposure errors. The disadvantage is that when the timer is switched on or the thumb-wheel switches are altered the enlarger lamp will turn on until the display shows the same figures as the thumbwheel switch. Normally, however, more time is taken in preparing the darkroom or setting up the next print, so that in practice no time is actually lost.

Circuit Description

The main timing of the unit is derived from the 50Hz mains frequency via the transformer T1. Diodes D1, D2, capacitors C1, C2 and voltage regulator REG1 provide the 12 volt power supply, which is applied to all the IC's. The +12V is attached to the highest numbered pin of the IC's (14 or 16) and the 0V to the diagonally opposite pin (7 or 8). In all cases unused inputs must be connected to either high or low supply to ensure correct operation or freedom from oscillation.

The timing pulses are derived from the 15V/50Hz output of T1, ie. approximately 21V peak to peak. The zener diode D3, fed via R1, clips this voltage to +12V when the input is positive and to -0.6V when the input is negative. This clipped sine wave is then applied to a schmitt trigger IC1a, which provides a square wave at 50Hz with short rise and fall times on the logic transitions. This 50Hz square wave is fed to IC2a connected with IC3c and IC3d to act as a divide by 5 counter. IC2 has outputs in BCD (binary coded decimal) which will normally count from 0 to 9 (0000 to 1001) but at a

count of 5 (0101) IC3 resets the counter immediately to 0. In this way after every 5 input cycles the output of IC3c connected to the reset pin of IC2a, gives a single short pulse every 0.1 seconds.

The connections for the operating switches S1 and S2 pass through IC1b and IC1d to provide the logic levels required for the operation of the counter reset and output logic stages.

The 10 pulses per second from IC3c pass through a count inhibit circuit IC10a and then to IC2b which produces 1 pulse per second when input 1 of IC10a is high. IC4 acts as a 00 to 99 counter with BCD output lines. This BCD data is used to drive a 7 segment double digit display, via display drivers IC5 and IC6. It should be noted that the ballast resistors used with the display are of unusually high values (R4-17) so that the display will show only a dull glow in the darkroom.

IC's 7, 8 and 9 provide a system which checks whether the BCD data on the output of IC4 and from the BCD thumbwheel switches S3 and S4 are the same. IC7 and IC8 are quad exclusive NOR gates which act as comparators for each of the BCD data line pairs.

Figure 1. Circuit diagram.
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When the values of BCD input are the same the output is high. IC9 is an 8 input NAND gate giving low output on pin 13 only when all of the 8 BCD input pairs are the same. It is this output which controls the counting and also the output circuitry when S1 and S2 are in their off positions. The output of IC9 is over-ridden by the logic levels derived from S1 or S2 when either switch is used.

The output logic circuit consists of IC11d, IC11a, IC11b, IC1b, IC10c, IC10d, IC1d, and TR1 which cause the opto-coupler diode to turn the output triac CSR1 on under the following conditions:—

1. If the system is counting, i.e. if pin 13 is high
2. If S2 is turned on, i.e. the input to IC1b is high.

If S1 is pushed the logic prevents the counter from operating and holds the triac off whilst resetting the counter to zero.

Assembly

Construction of the timer should cause no problems as all the components except for the switches, transformer and output socket are fixed to the PCB. The board is double sided and all components are mounted on side 2 of the board with most soldering carried out on side 1.

Insert the vertisocket into the board first as this will help with the identification of the other component locations, and solder into position noting that pins 1, 3, 6 and 8 going to resistors R8, R10, R11 and R13 must be soldered to both sides of the board. Insert and solder all of the IC sockets checking carefully the position of pin 1 as the IC's point in different directions, but DO NOT INSERT IC's.

Bend, insert and solder all of the resistors into their places noting that R8, R10, R11 and R13 will be soldered to both sides of the board, followed by capacitors C1 and C2. Next insert the opto-coupler, transistor, triac, regulator, and diodes and after checking orientation solder into place.

Attach a 30cm length of ribbon cable to the output holes for S3 and S4 and the 12V line on the right hand side of the board. It will be found that there is one spare wire and this may be pulled away from the rest of the ribbon cable. Then add further wires for the transformer, S1 and S2 connections, and short pieces of hook up wire to the mains input and output connections. If the board is now held up to the light there can be seen a large number of holes remaining and the track pins are inserted into these holes and soldered on both sides. If all of the pins are inserted before soldering it is very likely that a pin will be left unsoldered on one side of the board and this will cause problems later on. Personal experience has shown that it is best to insert about 6 pins and then count the solder joints being made on both sides of the PCB.

Assemble the thumbwheel switch from the component parts and identify

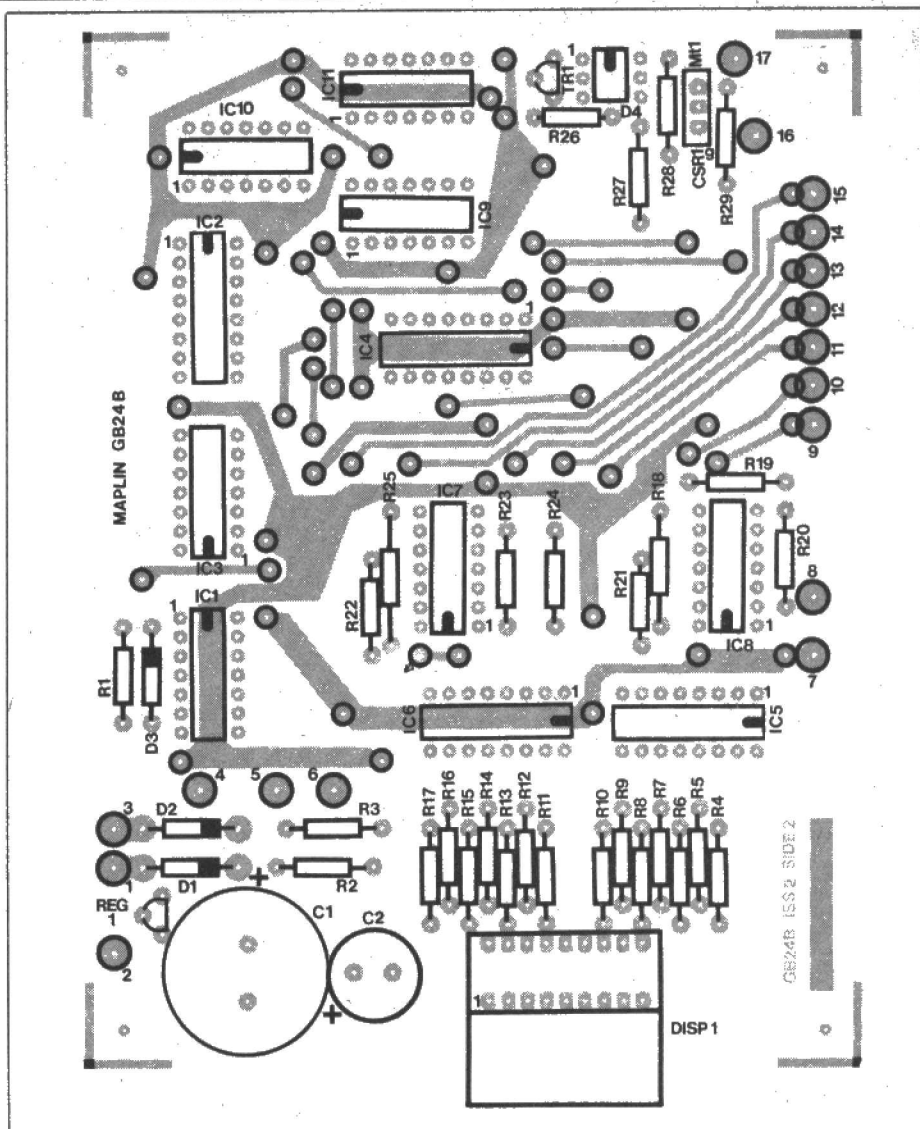


Figure 2. PCB layout.

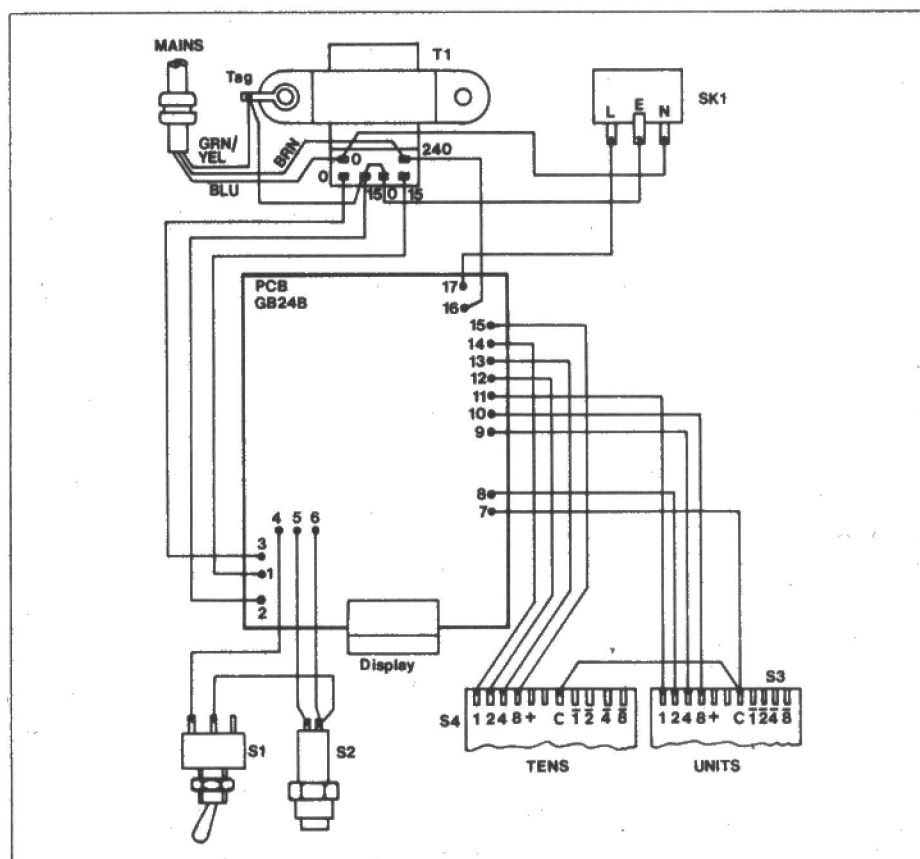


Figure 3. Interwiring diagram.

the 8, 4, 2 and 1 switch contacts as well as the common line C.

A suitable case should be chosen and drilled or cut to take the PCB with cut-out for the display, thumbwheel switch, Euro outlet, transformer, mains input grommet, and switches S1 and S2.

After mounting all of the components in the case connect these as shown in the wiring diagram Figure 3. The mains input earth **MUST** be connected securely to the metal case and to the Euro socket as failure to do this will make the timer dangerous to use in the wet atmosphere of the darkroom.

Circuit Testing

Insert a 3A fuse into the mains input plug. The constructor should remember that the large PCB carries mains voltages so extreme care should be taken whilst testing the circuits. First, and before inserting the IC's check that the 12V power supply is operating correctly by checking the voltage

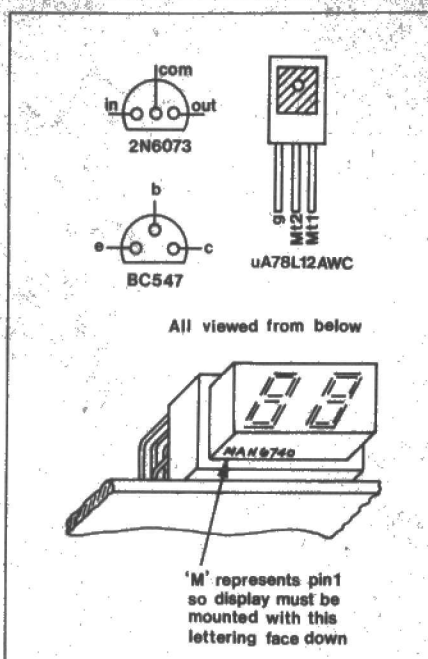
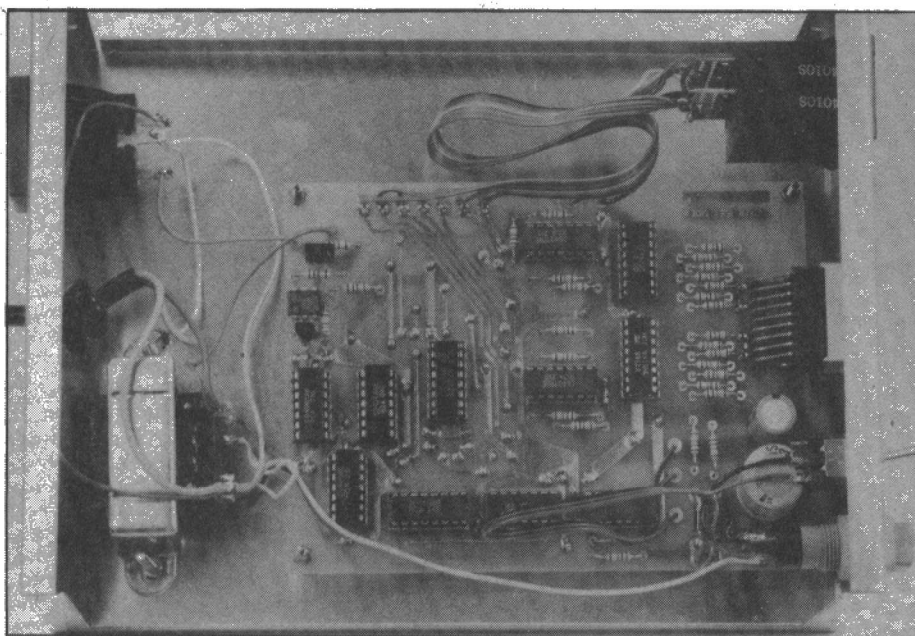


Figure 4. Pin configurations.



across pins 7 and 14 of IC1 socket.

Switch off and remove the mains plug. Insert all of the IC's and turn on again. The LED display should light (note the intensity of the lamps is low), count up to the number set on the thumbwheel switch at one count per second, and then stop. Also check that the thumbwheel switch has been connected correctly by making the counter stop at 0, 1, 2 to 9 and 10, 20 to 90 seconds. Finally pull out the mains plug and check that none of the components has become hot. Now connect a 100W/240V bulb across the output socket and repeat the above. During counting the lamp should light and go off when the count stops. Set S2 to the on position, the lamp should light but the display remain at the same setting. Press S1 and the display should reset to zero but the lamp remain off. Releasing the switch will allow the lamp to light for the required time.

Using the Timer

If all tests have proved satisfactory connect the timer to the enlarger, and set up the darkroom. Set the thumbwheel switch to the desired exposure time and switch S2 on, to prevent the lamp turning off whilst trying to set up the negative and baseboard. When you are ready, switch S2 on, place photographic paper in the baseboard, then press S1 and release to make the exposure.

Modifications Outside Great Britain

In countries with a mains frequency of 50Hz only T1 will need to be changed to a transformer having an input winding suitable for the local voltage.

In countries with 60Hz mains frequency the constructor must break the connection between IC2 pin 3 and IC3 pin 13. A new connection must be made between IC2 pin 4 and IC3 pin 13.

ENLARGER TIMER PARTS LIST

Resistors — All 0.4W 1% metal film.

R1-25 inc 10k
R26 680R
R27,28,29 1k

Capacitors

C1 470uF 63V PC electrolytic
C2 470uF 16V PC electrolytic

Semiconductors

D1,2 1N4001
D3 BZY88C12V
D4 Opto-triac-isolator
CSR1 2N6073
REG1 uA78L12AWC
TR1 BC547
IC1 4093BE
IC2,4 4518BE
IC3,10 4011BE
IC5,6 4511BE
IC7,8 4077BE
IC9 4068BE
IC11 4001BE

Miscellaneous

DISP1 DD Display Type C
Vertisocket Type 2

25 off (M10K) T1
(M680R) S1
3 off (M1K) S2
S3.4
SK1
2 off (QL73Q)
(QH16S)
(QQ10L)
(QR51F)
(WQ77J)
(QQ14Q)
(QW53H)
2 off (QX32K)
2 off (QX05F)
2 off (QX31J)
2 off (QW47B)
(QX24B)
(QX01B)

14 Pin DIL Skt
16 Pin DIL Skt
Veropin 2141
Track Pin
Transformer 15V
Sub-Min Toggle A
Square Push Red
Thumbwheel BCD
Thumbwheel End Cheeks
Grommet
Euro Facility outlet
Euro Facility plug
10-way Ribbon cable
Min Mains Black
Hook up wire
Case AB15
PCB
Screws 6BA x 1 inch
Nuts 6BA
Spacer 6BA x 1/2 inch
Screws 4BA x 1/4 inch
Nuts 4BA
Tag 4BA
Stick-on-feet

7 off (BL18U)
4 off (BL19V)
1 pkt (FL21X)
2 pkts (FL82D)
(WB15R)
(FH00A)
(FF98G)
2 off (FF84F)
(BK49D)
(FW59P)
(HL42V)
(HL43W)
1 metre (XR06G)
2 metres (XR01B)
1 pkt (BL00A)
(XB71N)
(GB24B)
1 pkt (BF07H)
1 pkt (BF18U)
1 pkt (FW35Q)
1 pkt (BF02C)
1 pkt (BF17T)
1 pkt (BF28F)
(FW38R)

A complete kit of all parts, excluding the case, is available.
Order As LK07H: (Enlarger Timer kit). Price £27.50.

Say it with SATELLITES

Part 4
by Mike Wharton



Giotto Spacecraft

Since this is the last in the present series of articles, we will finish off by taking a look at some of the current events on the space scene. The use of satellites is only one aspect of a much wider field, that of the exploration of space. After an initial impetus during the late 1960's, which culminated in the American Moon landings, the exploration of space has become more the exploitation of space. During the last ten years there have been steady advances in the science and technology involved, and it may well be that manned exploration will eventually follow where the Pioneer and Voyager space-craft have led the way towards this 'final frontier'.

Ups and Downs

Despite the complexity and marvellous technology in this area of human endeavour, it still manages to prove the truth of that old saying 'what goes up must come down'; well, at least they come down quite often! Perhaps one of the more important 'downs' in the recent past was that of COSMOS 1402. This was a Soviet low-altitude surveillance satellite, and its demise proved to be newsworthy because of the descent of the radio-active portion of the space-craft.

The radio-activity is produced by special nuclear 'batteries', powered by a radio-thermal source in part of the satellite. This is kept as far away from the rest of the instrumentation and other sensitive areas of the satellite since radiation can play havoc with some of the electronic equipment on board. Also, the amount of shielding is kept to a minimum, since it is not expected that anyone will come into contact with the satellite once it is in space, and any effective shielding would only represent a dead weight in the pay-load.

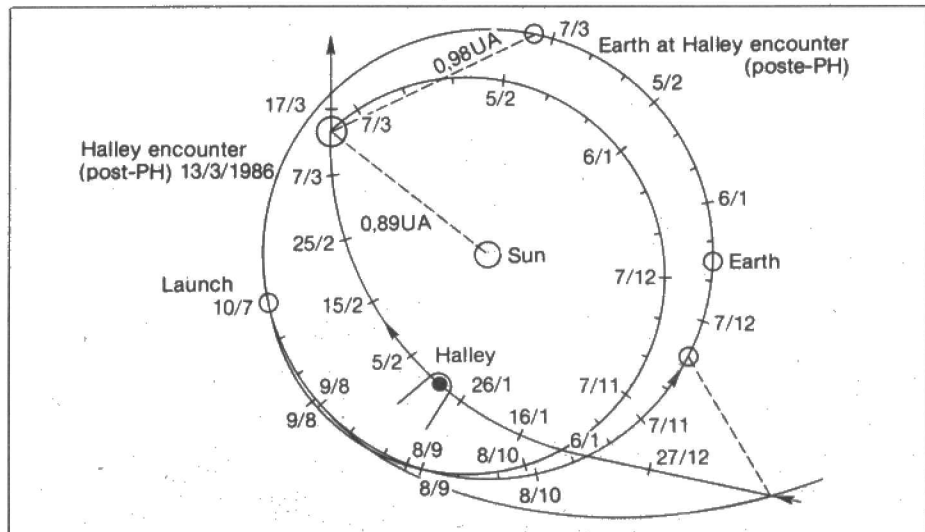
The reason why such sources are used, in addition to the usual solar arrays and conventional batteries, is to provide the large

amounts of power needed to operate the ground searching radars. These are used in this type of 'spying' operation since purely optical methods can be rendered completely ineffective by even the lightest covering of cloud, which, of course, does not affect radar.

Usually, this type of satellite containing a radio-active source would be manoeuvred from its normal orbital path into a much higher parking orbit at the end of its useful life. It would then be left there while the radio-activity decayed to safer levels; then it could be either left there, virtually forever, or brought down to an altitude where atmospheric drag would take an effect, and it would then burn up during re-entry through the atmosphere.

It seems that in the case of COSMOS 1402 control of the satellite was lost, and

proved impossible to push it out into its parking orbit. This meant that it started to re-enter the Earth's atmosphere before the radio-active source had been given a chance to decay. This should not have been a problem, since this was its intended fate anyway, but since control of it had been lost it was impossible to put it into an orbit that would ensure complete vaporisation of the dense radio-active source. In the event, it seems that the villain of the piece fell into the South Atlantic, even if it did remain intact on re-entry. The point is worth making that even if such sources are 'burned up' on re-entry, this does not destroy the radio-activity present, for once formed it is not possible to destroy an isotope by such physical methods as burning. However, by vaporising it in the upper atmosphere, the radio-activity is dispersed to such an extent that harmful levels



Giotto reference transfer orbit with a launch on 10 July 1985 and a Halley encounter on 13 March 1986.

of radiation should not be experienced by anyone on the ground.

Many of these surveillance satellites, put into orbit by both the USA and the USSR, contain such radio-active sources and this was not the first to cause concern; it may be remembered that a piece of similar Soviet space debris fell on northern Canada some three years previously. It seems a safe bet that sooner or later the same thing will happen again.

A Satellite for Sport

The satellite's vantage point from its orbit some 900 km. out in space provides the basis for one of its most useful roles, that of satellite navigation. There are several systems which make use of this facility, such as the Marecs satellites operated by Inmarsat. These satellites provide a means by which commercial shipping can obtain a much more accurate fix of their position at sea than ever was possible by dead reckoning. One disadvantage of this type of system to the average yachtsman is its fairly high cost for the receivers and associated computing equipment.

A system presently operated by the US Navy, and soon to be updated, is based on satellite navigation by their so-called Transit satellites, and known by many yachtsmen as SATNAV. The development of modern microprocessor based computing devices has ensured that this method is reasonably cheap to install. Like many other such navigation aids, it uses the Doppler shift between two signals to provide data for the calculation of latitude and longitude at sea. For greater positional accuracy, it may be interfaced with the compass and ship's log, the latter being the device which gives the ship's speed. At the present time there are five satellites, with one more to be launched shortly, so there are still some gaps in the system. The satellites used for this method occupy a polar orbit, with a period of about 100 minutes. Each satellite transmits beacon signals on 150 MHz and 400 MHz which are picked up by the receiver on board the yacht. The transmitted signals are compared with a very stable signal generated by the equipment. Since the satellite is moving very rapidly, its signal will appear to rise and then fall in frequency as it passes by on its orbit, just like the old example of the whistle on a steam train - this is Doppler shift. The satellite always knows where it is above the surface of the Earth, and by making some computations based on the magnitude of the Doppler shift, the position of the yacht may be found relative to the satellite.

If the yacht is moving, then this factor can also be taken into account, and the final result should have an accuracy of about 300 metres, although it is theoretically possible to obtain your position to within 100 metres.

This system is to be superseded shortly by a new Global Positioning System, or GPS, called NAVSTAR, which will give a new meaning to the old nautical phrase, "a star to steer by".

International Rescue Takes Off

The method of using Doppler shift to calculate the position of an object on the surface of the Earth can also be used in the opposite sense, that is, for the satellite to determine the position of a fixed beacon. This is the basis of a project which Britain has recently joined, and which will use satellites to locate crashed aircraft or shipwrecked mariners. The other countries involved are the US, Canada and France, who will join up their SARSAT system with the Soviet COSPAS system. SARSAT, or Search And Rescue Satellite Aided Tracking is a

method which uses satellites to pick up the transmissions from distress beacons on the ground or in the sea. COSPAS-1 was launched in the middle of last year, and an American satellite, to be operated by NOAA, should follow it up on March 28th this year. These satellites will pick up transmissions from emergency beacons which are automatically turned on in the event of an accident. Those carried on board an aircraft should operate due to the jolt of the crash, whilst those on a ship operate when immersed in water.

These beacons have to be carried by law, but it is by no means an easy task to locate their position from ground based receiving stations or even over-flying aircraft. This is where the satellite's superior vantage point comes into its own. The beacons transmit on the international distress frequencies of 121.5 MHz and 243 MHz for at least two days; aircraft flying over the sea are obliged to monitor these frequencies, but not whilst they are flying over land. A satellite in a polar orbit can monitor the whole surface of the globe, again having a period of around 100 minutes, so that any transmitting beacon will be located in a relatively short time. The signal from a beacon is recorded as the satellite passes close by, and then the Doppler shift compared to a reference signal is used to work out its position relative to the satellite. This information is 'dumped' via

dust and water vapour contained in it can completely obscure some parts of the electro-magnetic spectrum which are of interest.

This is especially true of a wide range of infra-red (I-R) wavelengths, which are absorbed by water vapour in the air. To overcome this problem, a satellite has recently been launched called IRAS, or Infra-Red Astronomical Satellite. This carries on board a set of special sensors which will be used to study the emission of infra-red by certain parts of the galaxy. Infra-red, of course, is heat energy, and to make the sensors as sensitive as possible they are cooled down to a very low temperature. On IRAS this has been achieved by the use of liquid helium, contained in a special vacuum flask, and which is able to cool the sensors down to within a few degrees of absolute zero. The telescope will only be able to operate whilst the supply of liquid helium lasts, and the astronomers in charge of the project are pleased because it seems that the helium may last for up to 300 days, rather than the 200 days originally calculated.

Because of the extreme sensitivity of the infra-red sensors, one glance at anything as bright as the Sun would destroy them immediately. For this reason the satellite has been put into a special orbit, called sun-synchronous. This is a polar orbit, but the orbital increment is so arranged that the



telemetry when the satellite comes in range of a ground station, and the position of the distress beacon calculated. This gives a very precise location for the rescue craft to home in on and hence remove much of the uncertainty and guesswork often involved in trying to locate the position of a craft in distress, particularly at sea and in bad weather conditions. A development of the system will use beacons which operate on a higher frequency of 406 MHz, in a less cluttered part of the radio spectrum, and has a potential accuracy of some 2 to 5 km, rather than the 20 to 50 km. with the presently envisaged system.

I-R Astronomers over the Moon

So far, all the various satellite systems considered have had their attention directed towards the surface of the Earth. This need not necessarily always be the case, for there are a number of satellites whose attention is very clearly on outer space. Amongst these are the special telescopes which have been carried aloft within a satellite in order to obtain a better view of the Universe. The reason for doing this is usually to place the telescope above the Earth's atmosphere so that it cannot interfere with the incredibly weak signals which the astronomers are looking for. Indeed, the atmosphere and the

satellite always faces away from the Sun. To protect the sensors during launch, a cover was placed over them; the first signals received from the satellite when it was put into operation was the minute infra-red trace from these covers as they were jettisoned and drifted away into space. At the time of writing the telescope has only just begun its operational life, but it is reported that one minute of observation has revealed more than was previously known about this part of the spectrum from all Earth bound observations.

On Track for Halley's Comet

Many reader will no doubt be aware that Halley's comet is due to reappear during the next few years. This is one of the more spectacular of these heavenly bodies, although it is not expected to be such a sight in the night sky as on its last appearance 75 years ago. There is a great deal of speculation amongst astronomers as to what the composition of a comet actually is. It is generally agreed that the head consists of frozen water or gases, along with some rock and that the tail is a very thin stream of this material evaporated by heat from the Sun and flowing out in the solar wind, so that it always points away from the Sun. One way which could provide a lot more information

continued on page 62

With sales of the Commodore 64 steadily rising there must be a vast number of users becoming increasingly frustrated in the knowledge that they are the proud owners of a powerful and yet undocumented machine.

The users manual which accompanies the 64 is extremely basic, and continually makes reference to the Programmers Reference Guide for more information on the concepts of advanced operation. Where is this Oracle? No doubt it will materialise in time, but for all you Commodore 64 owners here are some routines to whet your appetites.

Joysticks

The 64 has two control ports which are controlled by one of two CIA chips. these are 6526's and control the I/O

and interrupts etc. CIA 1 handles IRQ whilst CIA 2 handles NMI. To read the joystick switches use the following
 JY = NOT PEEK(56320) AND 15
 this will yield 1 for UP, 2 for DOWN, 4 for LEFT, 8 for RIGHT, and the appropriate combinations for the diagonals. To read the fire button use
 FB = NOT PEEK(56320) AND 16
 (I have used Port B. Replace address with 56321 for Port A.)

High Resolution Graphics

Another feature of the Commodore 64 is its high resolution graphics facility. This is not even hinted at in the manual - so here it is. The screen has its

by Nigel Fawcett

Pixels arranged in a 320 by 200 matrix. In normal operation the screen requires 1000 bytes of RAM to hold the code for each of the 1000 possible character positions. In Bit Map Mode every Pixel on the screen needs to be addressable - 64000 bits are needed and one byte contains 8 bits - so 8000 bytes will be required in RAM to enable high resolution graphics. Program 1 is written in basic to demonstrate this facility.

You will notice that in this mode the screen memory starts at 24K, and the colour memory starts at 16K. The screen will be completely blank, but due to the slow nature of BASIC it adequately demonstrates how the screen is mapped. Program 2 executes the same function in machine code (somewhat faster), and then allows the screen to be used as a doodle pad with a joystick in control Port B.

USING THE COMMODORE 64

```
100 V1=56576:V2=53248
105 RESTORE
110 FOR I=0 TO 42
120 READ A:POKE 832+I,A
130 NEXT I
140 POKE V1,PEEK(V1) AND 254
150 POKE V2+24,8
160 POKE V2+17,PEEK(V2+17) OR 32
170 SYS 832
1000 C1%=0:C2%=0:B1%=0:B2%=0
1010 JY=NOT PEEK(56320) AND 15
1020 IF JY AND 1 THEN GOSUB 11000
1030 IF JY AND 2 THEN GOSUB 12000
1040 IF JY AND 4 THEN GOSUB 13000
1050 IF JY AND 8 THEN GOSUB 14000
1060 IF NOTPEEK(56320) AND 16 THEN 105
1070 GOTO 1010
2000 GOTO 2000
3000 DATA 162,32,160,0,169,0,141,0,96,238,71,3,136,208,245,238,72,3,202,208
3010 DATA 239,162,4,160,0,169,2,141,0,64,238,92,3,136,208,245,238,93,3,202
3020 DATA 208,239,96
10999 RETURN
11000 B1%=B1%-1:IF SGN(B1%)<0 THEN 11100
11010 B1%=7:C1%=C1%-1
11020 IF C1%<0 THEN C1%=24
11100 CH=C1%*320+C2%*8+B1%+24576
11110 POKE CH,PEEK(CH) OR (2*182%)
11999 RETURN
12000 B1%=B1%+1:IF B1%<8 THEN 12100
12010 B1%=0:C1%=C1%+1
12020 IF C1%>24 THEN C1%=0
12100 CH=C1%*320+C2%*8+B1%+24576
12110 POKE CH,PEEK(CH) OR (2*182%)
12999 RETURN
13000 B2%=B2%+1:IF B2%<8 THEN 13100
13010 B2%=0:C2%=C2%+1
13020 IF C2%>39 THEN C2%=0
13100 CH=C1%*320+C2%*8+B1%+24576
13110 POKE CH,PEEK(CH) OR (2*182%)
13999 RETURN
14000 B2%=B2%-1:IF SGN(B2%)<0 THEN 14100
14010 B2%=7:C2%=C2%-1
14020 IF C2%>39 THEN C2%=0
14100 CH=C1%*320+C2%*8+B1%+24576
14110 POKE CH,PEEK(CH) OR (2*182%)
14999 RETURN
32767 END
```

Program 2

```
100 V1=56576:V2=53248:
140 POKE V1,PEEK(V1) AND 254:
150 POKE V2+24,8:
160 POKE V2+17,PEEK(V2+17) OR 32:
170 FOR X=0 TO 8191:
180 POKE 24576+X,0:
190 NEXT X
200 FOR X=0 TO 1023:
210 POKE 16384+X,1:
215 REM:
220 NEXT X
300 GOTO 300:
32767 END
```

Program 1

```
REM POINTERS TO CIA AND VIDEO CHIPS
REM SET UP CIA CHIP
REM RECONFIGURE SCREEN MEMORY MATRIX
REM ENABLE BIT MAP MODE
REM 8K FOR SCREEN MEMORY MAP
REM CLEAR MEMORY
```

```
REM 1K FOR COLOUR MEMORY
REM SET COLOUR TO WHITE - CHANGE THIS
REM FOR ANY COLOUR CODE 0-15
```

```
REM RUN/STOP & RESTORE TO BREAK OUT!
```



COMPUTER NEWS

Returning by popular demand for a second year, the Computer Fair at Earls Court reflects just how important the micro is becoming. The Fair is being held from the 16th to the 19th of June, and the doors will be open from 1 p.m. to 6 p.m. on the 16th, 10 a.m. to 6 p.m. on the 17th and 18th, and 10 a.m. to 5 p.m. on the 19th. Admission prices will be £3 for adults, children under sixteen and OAPs £2, and special reduced price vouchers will be printed in the magazines sponsoring the event. There are also reductions for group advance bookings. Further details can be obtained by ringing 01-643 8040 ext. 4859.

British Rail are also offering reduced price inclusive return tickets, e.g. a return rail ticket and admission to the Fair will cost you only £5.80 if you live in Essex. For more details contact the Travel Centre at Kings Cross Station, or phone 01-278 2477.

Amongst the items on offer from the organisers of the Fair are a Sinclair Village, a Club Avenue, and a Micro Mouse contest. Indeed the Fair will be bigger than last year, held in a larger area, and open for longer.

The Maplin stand will be showing our extensive range of computers and

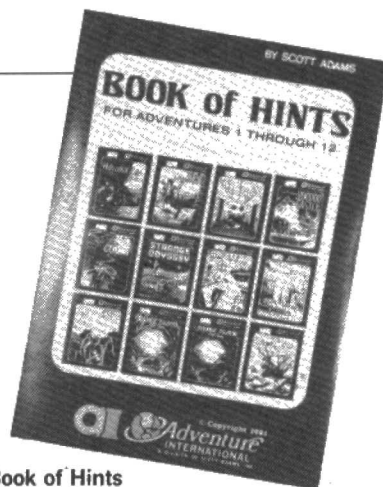
THE Computer Fair

Personal computers
Home computing
Small business systems

**June 16th
to 19th 1983**

software, all of which will be available for purchase, PLUS a demonstration of the abilities of the new M5 computer from Sord, providing it is here on time. There will also be a whole host of books and literature for you to choose from, and free leaflets on hardware and software will be placed about the stand.

Our technical staff will be at hand to provide you with help and advice should you require it, and there will be a representative of the U.K. Atari User Group present, to talk to those of you have already bought, or are seriously thinking of investing in one of the Atari range of computers and peripherals.



Book of Hints

by Scott Adams

Never let it be said that Scott Adams doesn't provide at least some help for the perplexed Adventurer! His hint book contains additional clues to help you out of some of the sticky spots you have got into, while still letting you solve the Adventure yourself - all without giving away any of the clues until you really want them! So if you really can't seem to get out of the bog or locate the Pharaoh's heart, then this is the right place for help. This expanded edition includes hints for all twelve Adventures, and a special section on the making of Adventure maps. Relief at last! 1982. 14 pages. 190 x 133mm.

Order As WK25C (Book of Hints)

Price £4.99 NV

```

1000 POKE 56334,PEEK(56334) AND 254:
1010 POKE 1,PEEK(1) AND 251:
1020 FOR I=0 TO 2047
1030 POKE 12288+I,PEEK(53248+I):
1035 REM:
1040 NEXT I
1100 POKE 1,PEEK(1) OR 4:
1110 POKE 56334,PEEK(56334) OR 1:
1200 FOR I=13312 TO 13327:
1210 READ C:
1220 POKE I,C:
1230 NEXT I
1300 POKE 53272,(PEEK(53272) AND 240)+12
1305 REM:
1306 REM:
2000 PRINT "J":
2010 PRINT "##### !!!!!":
3000 DATA 0,0,0,0,3,12,48,192,3,12,48,192,0,0,0,0
    
```

REM SET UP CIA CHIP

REM SET UP I/O DIRECTION

REM COPY THE CURSOR UP MODE CHARACTER

SET INTO RAM STARTING AT 12K

REM RESET THE I/O DIRECTION

REM RESET THE CIA CHIP

REM ALTER THE CHARACTERS WHICH NORMALLY

REM HAVE SCREEN CODES 120 & 129

REM (NORMALLY REVERSE 0 AND REVERSE A)

REM TELL THE VIDEO CHIP WHERE THE NEW

REM CHARACTER SET IS

REM CLEAR SCREEN

REM INVERSE 0 AND INVERSE A !!!!

Program 3

```

1000 POKE 52,48:POKE 56,48:CLR
1010 FOR I=832 TO 860
1020 READ A
1030 POKE I,A
1040 NEXT I
1050 POKE 56334,PEEK(56334) AND 254
1060 POKE 1,PEEK(1) AND 251
1070 SYS 832
1080 POKE 1,PEEK(1) OR 4
1090 POKE 56334,PEEK(56334) OR 1
1100 FOR I=13312 TO 13327
1110 READ C
1120 POKE I,C
1130 NEXT I
1140 POKE 53272,(PEEK(53272) AND 240)+12
30000 DATA 162,8,160,0,173,0,208,141,0,48,238,69,3,238,72,3,136,208,241,238
30010 DATA 70,3,238,73,3,202,208,232,96
31000 DATA 0,0,0,0,3,12,48,192,3,12,48,192,0,0,0,0
    
```

Program 4

Redefining the character set

The 4K of memory required to generate the 512 characters available resides in ROM starting at memory location 53248. This may come as a surprise to those who are already aware that the video chip controlling the sprites starts at the same address. Reading the character ROM can only be achieved when the I/O chips are correctly configured, as program 3 will show.

For those who were again disappointed by the slowness of BASIC, Program 4 performs the same function using machine code.

These demonstration programs do not by any means explain the full power or capabilities of the Commodore 64. There are many other places in RAM at which the character set can be set up and redefined. This is not the only method of creating a bit mapped screen - multicolour modes have not been shown nor has the ability to fine scroll or mix Hi-res graphics with text - this is just meant as an insight into the possibilities that exist when programming on this machine. Full details will be found in the Programmers Reference Guide and more programs and ideas will be given in future editions of Electronics. Good programming.

SAY IT WITH SATELLITES

continued from page 55

on the subject is if it were possible to obtain samples from such a comet, and carry out an analysis. Until recently this would have been an astronomer's pipe-dream, but with the advent of satellites it has now become a real possibility.

The European Space Agency and British Aerospace have designed a £34 million contract for the Giotto space craft. This will be Europe's first deep space probe, although as such it may seem to be stretching the label of 'satellite' a long way. It is due to be launched during July 1985, and to intercept the comet about eight months later. Giotto will carry some of the most advanced instrumentation available and pass closer to the comet than either the Russian or Japanese probes which are also to be sent in its direction. It is hoped to carry out a chemical analysis of the comet and take colour photographs of the nucleus and also take measurements of surrounding magnetic fields.

Finally, back to the Box

The Box referred to is, of course, our old friend the TV. Developments in Direct Broadcast by Satellite, DBS, seems to be three steps forward and two steps back, and it is getting difficult to predict just when the average 'consumer' may expect to enjoy the delights of such a scheme. The background technology involved was outlined in a previous article in this series, and the present state of play appears to have the BBC and IBA knocking the ball backwards and forwards between them. With such a wide ranging system it is vital that common standards of transmission are used, and this is where one of the present problems lies.



The IBA have proposed a transmission system called MAC (for multiplexed analogue component), whilst the BBC are pushing an improved version of the commonly used PAL method, known as Enhanced PAL. There is actually a third contender which is a hybrid digital/analogue system, but it seems very likely that it will turn out to be an 'also ran', since it is only just at the early stages of development and there is reckoned to be insufficient time for it to be brought up to the same standard as the two main systems in the race. This is despite the acknowledgement by the Part Committee, the Government body who have the responsibility for deciding these matters, that it is an elegant and ingenious method. It could well be that there is some professional jealousy involved, since it appears highly probable that the IBA's MAC system will be the one recommended by the Committee and eventually put into service.

The reasons for having several systems to choose between is because although DBS has many advantages over terrestrial broadcasting, it is not all plain sailing, and as usual there are some trade-offs to be considered.

E-PAL is attractive because it is com-

patible with existing decoders, all that would be needed to receive pictures from a satellite transmission is an antenna and a down-converter. On the other hand, the MAC system will require the use of a more elaborate decoder which produces separate RGB (red, green, blue), outputs to give a better picture. Thus to receive these TV transmissions, one will need a MAC-to-PAL converter and an r.f. modulator to drive the antenna input of a standard television. Future sets would contain their own decoders, but this would make them more expensive.

The third contender, mentioned above, uses a digital encoding technique, very similar to methods which have already proved themselves in other satellite systems. Only time will tell how this situation will be resolved, but it looks as though it is going to be a few years before it is possible to watch the Muppets in half a dozen different languages!

There are always new developments in the application of electronics to the field of satellites and in future these will be published as an occasional "Space News" feature.

D'XERS AUDIO PROCESSORS

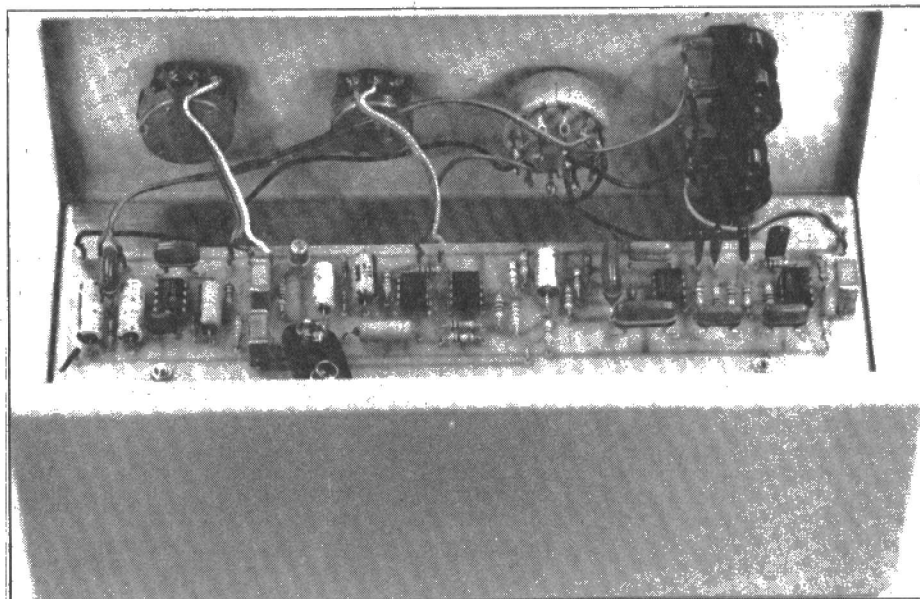
continued from page 47

In Use

Satisfactory results will probably be obtained if the unit is fed from either a loudspeaker socket or a headphone output of the receiver. If fed from an output intended for low impedance headphones the unit may provide inadequate output for use with a loudspeaker or high impedance headphones. This is not likely to happen in practice, but if necessary R22 could be replaced with a link wire to provide an increase in gain.

The processor will drive any normal type of headphones, but with some low impedance types the output of the unit may be excessive. This can be overcome by adding a resistor of about 100 ohms in value in series with one of the leads to JK2. An 8 ohm impedance loudspeaker can be driven at good volume, and higher impedance loudspeakers are also suitable, but the maximum output power decreases roughly in proportion to any increase in loudspeaker impedance. The use of a speaker impedance of less than 8 ohms is not recommended.

When the expander is not required RV1 is set in a fully anticlockwise direction. It is not advisable to always use the expander section of the pro-



cessor since it will be of little or no benefit if the wanted signal is badly affected by noise or interference, and under these conditions the expander may be unable to function at all. It is not advisable to use the expander when trying to receive a station which is fading badly since the expansion will simply make the fading worse.

If reception conditions are not very poor and the expander is to be used, RV1 is advanced in a clockwise direc-

tion to give the desired degree of expansion (a roughly mid-point setting should be satisfactory). VR2 is then adjusted so that the wanted signal readily operates the expander and is reproduced at full volume, but during pauses in the wanted signal the background noise or interference does not and is consequently attenuated. After a little experimentation there should be no difficulty in setting these controls for optimum results.

CLASSIFIED

HI-FI FOR SALE

TANDON 8" DSDD dual disk drives, slim line, cased with p.s.u., £250 ono. May deliver (may exchange for good micro, BBC etc.), 12" ex Juke Box speakers, £2 each. 01-690 3131.

STEREO CASSETTE deck, Sharps RT480H, DoLBI NR-CR02 switched bias, separate record/playback balance controls, twin VU meters, h/phone & mic sockets, Ferrite heads, 1st class condition, bargain at £50. (098371) 2348.

SHURE V15 III boxed cartridge, used one week, with guarantee, £25. Maplin 150W amp, built, £10 and psu, £15 as page 228 Maplin catalogue. Tel. Dave 051 426 5742.

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APPROXIMATELY 500 470k ¼W resistors, worth about £10. Will sell for £1.50. Telephone Chris on Darwen (0254) 771303 (evenings).

FOR SALE, Everyday Electronics Magazines, Volumes 1 to 8 inclusive, in binders. Offers: 24, Greenhill Rise, Carlton, Nottingham. 0602-611173.

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DUAL BEAM oscilloscope for sale, working order, but needs little attention, old model, size 21 x 14 x 8 inches. Price £250 ono. Tel. 01-644 3833.

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MAPLIN 5600S synthesizer, fully built, sizzling sounds, four oscillators, two VCAs, envelope, transients, filters, noise, joystick, external I/PS, footpedal etc. Ideal studio machine, £750. (0732) 863237 (Edenbridge).

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5600S SYNTHESISER, only requires £50 of components to complete. All made PCBs working although not set up. Further details, offers to Karl Simpson, 5, Verbena Way, Worle, Weston Super Mare.

WANTED

WANTED CHANNEL "F" Videocart cartridges for use with Fairchild video entertainment system. Tel. Oxford 53483.

TRANSCENDENT DPX required, must be in good condition, unfinished kits considered, £100. Tel. Cliff, Southampton 582215.

HORIZON RADIO control equipment, T. Beckett, The Poplars, Harringworth Road, Seaton, Oakham LE15 9HZ. Morcott 876.

WANTING two used five oct. keyboard with contacts, offer best price. A. K. Banerjee, Sebast Kneipp G 4/3/10, A1020 Vienna/Austria/Europe.

WANTED: 4600 synthesiser patchboard. Tel. David 01-385 0182.

PHILIP TYPE EL3514/15 tape recorder, manual or circuit, required. Box No 4.

FIRST BASE continued from page 49

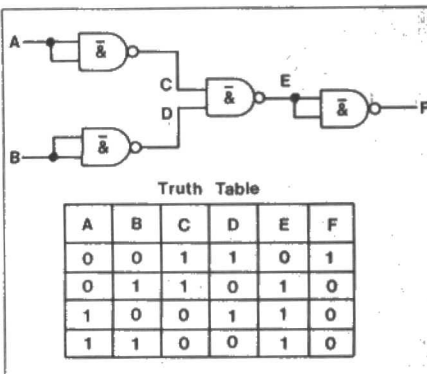


Figure 10.

Two input NOR gate using four NAND gates.

NAND gate you can find the value of the inputs to the third gate, C and D. Continuing this process gives the input to the fourth gate, E, and finally the output F. Repeating this procedure for the other combinations of logical inputs will give the rest of the Truth Table.

Figure 11 shows another logic array using NAND gates, but it is left to you to work out the relevant Truth Table. You should obtain

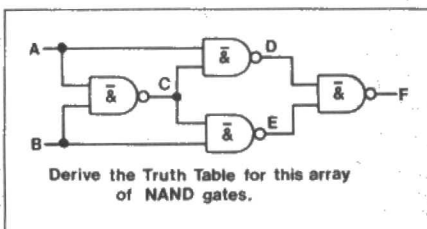


Figure 11. NAND gate array.

that for an important logic gate which has not been mentioned yet, and which can be obtained in a single package, and the solution will be given in the next article.

A Practical Solution

No doubt some of you are thinking that this is a rather theoretical approach to the problem, and would prefer a practical solution which actually involves using chips. This is the next stage in our progression along the way.

Those who are unfamiliar with making up circuits using these types of component may welcome a few guide-lines. First and foremost you will need something on which you can mount the integrated circuit package and make connections to the various pins. It is possible to solder fine wires directly to the pins, but the chips are not going to last very long this way and it is definitely not to be recommended. The most suitable method is to use one of specially made 'breadboards', such as those shown on page 200 and 201 of the Maplin catalogue. These may seem rather expensive just for messing about with a couple of chips, but if you intend studying this aspect of the subject further then they are a very good investment for the future. As a practical exercise try making up the circuit shown in figure 11; first copy out the diagram and add the pin numbers, taken from the illustration of the 7400 in figure 8. Next make the connections between inputs and outputs using fine wire, solid core bell wire of 0.6mm diameter is ideal for this. Don't forget the connections to +5V for Vcc and 0V for GND. The inputs A and B in the diagram can be connected to +5V for logic 1, or 0V for logic 0; if you leave them 'floating', that is not

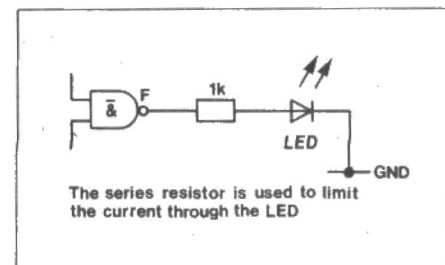


Figure 12. LED connection.

connected to either logic 1 or 0, the inputs of these devices will tend to float high, ie assume a value of logic 1. To find out what the logic level of the output F is for the various combinations of input there are several methods which may be used. If you possess a simple voltmeter capable of indicating around five volts or slightly more, then use that, remembering that +5V represents logic 1. Alternatively, a small Light Emitting Diode, LED is very useful, and these will be used in some of the later circuits. To indicate a logic 1 when lit, the LED should be connected to the output as shown in figure 12; a value of 1k is given for the resistor to limit the current taken to a safe level. The LED may seem rather dim, especially if viewed in bright light, but the temptation to reduce the value of the resistor to make the LED brighter should be avoided. For the same reason, low voltage bulbs should not be used as these take more current than the chip can safely supply, and you may find that you have cooked your chips!

Next time we will have a look at further combinational logic circuits and how they are used in practical situations.

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